ROBOTS SOCIALES Y ANIMALES EN LA TERAPIA DE PERSONAS CON DEMENCIA AVANZADA

Tesis Doctoral

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ROBOTS SOCIALES Y ANIMALES EN LA TERAPIA

DE PERSONAS CON DEMENCIA AVANZADA

Tesis presentada por Meritxell Valentí Soler

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A mi familia, por su apoyo incondicional,

a mis amigos, por su inspiración,

a mis profesores, por guiar mi formación.

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CLAVE DE ABREVIATURAS

Por orden alfabético:

- **APADEM-NH**: Escala de Apatía para pacientes con demencia institucionalizados – versión residencia (the Apathy Scale for Institutionalized Patients with Dementia - Nursing Home version)
- **C**: Control
- **CAFRS**: Centro Alzheimer Fundación Reina Sofía
- **CIEN**: Centro de Investigación en Enfermedades Neurológicas
- **CV**: Calidad de Vida
- **D**: Perro
- **DCL**: Deterioro Cognitivo Leve
- **DSM IV**: Manual de Diagnóstico y Estadística de las Enfermedades Mentales (Diagnostic and Statistical Manual of Mental Disorders)
- **EA**: Enfermedad de Alzheimer
- **EP**: Enfermedad de Parkinson
- **GDS**: Escala de Deterioro Global de Reisberg (Global Deterioration Scale)
- **IA**: Inventario de Apatía (Apathy Inventory)
- **MMSE**: Mini Examen Cognoscitivo (the Mini Mental State Examination)
- **N**: NAO
- **NAO**: Robot humanoide NAO
- **NPI**: Inventario Neuropsiquiátrico (NeuroPsychiatric Inventory)
- **P**: PARO
- **PARO**: Robot mascota con forma de cría de foca PARO (denominada NUKA en España)
- **QUALID**: Escala de Calidad de Vida en demencia avanzada (the Quality of Life in Late-stage Dementia)
- **SD**: Desviación estándar
- **sMMSE**: Mini Examen Cognoscitivo Grave (the Severe Mini Mental State Examination)
- **URJC**: Universidad Rey Juan Carlos

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Antecedentes:

Las personas con demencia pueden padecer trastornos de comportamiento que disminuyen su calidad de vida y aumentan el coste de su cuidado y el desgaste de su cuidador. La terapia con animales desde hace años se conoce como beneficiosa para reducir dichos síntomas. Los robots mascotas podrían proporcionar estos efectos positivos sin los inconvenientes de los animales. La terapia con robots podría ser una alternativa a la terapia con animales para reducir los trastornos de comportamiento y aumentar la calidad de las personas con demencia.

Hipótesis y objetivos:

Este trabajo trató de validar, en un centro donde reciben atención multidisciplinar pacientes con enfermedad de Alzheimer y otras demencias, las siguientes hipótesis:

- los robots sociales y los animales pueden:
  - ser aceptados por personas con demencia institucionalizadas en España, e incluirse en el modelo de terapia ocupacional que se utiliza actualmente en los pacientes con demencia, adaptándose al grado de afectación de la persona,
  - mejorar el comportamiento del paciente, permitiendo así mantener o reducir la medicación indicada para dichos trastornos conductuales
  - aportar una mejoría en la calidad de vida,
- el robot social humanoide mejorará más los trastornos del comportamiento y la calidad de vida respecto a un robot mascota, por el uso del lenguaje oral, su mayor movilidad y la mayor interacción
- los animales mejorarán más los trastornos del comportamiento y la calidad de vida respecto a los robots mascota, por su mayor interacción

El objetivo primario del proyecto fue la comparación de una terapia basada en la utilización de robots sociales o animales frente a la terapia ocupacional habitual, en relación a:

- las alteraciones de comportamiento y su necesidad de medicación, y
- la calidad de vida

Los objetivos secundarios del proyecto fueron:

- la comparación del efecto de las terapias entre sí (robot mascota con robot humanoide y robot mascota con animal), y
- la optimización de las sesiones terapéuticas para investigaciones adicionales y/o implantación.

Material y métodos:

Estudio exploratorio utilizando un robot humanoide (NAO), un robot mascota (PARO) y un animal real (PERRO) en las sesiones terapéuticas de personas con demencia en una residencia para objetivar posibles cambios en la sintomatología neuropsiquiátrica de los participantes, en la medicación psicoactiva prescrita y en su calidad de vida. Comparar el efecto de dichas herramientas entre ellas y con el grupo control.

Los pacientes fueron divididos en tres grupos según la gravedad de su demencia: leve-moderada, moderada-grave y grave. Dentro de cada grupo de gravedad, los participantes se asignaron aleatoriamente por bloques a uno de los tres brazos terapéuticos para comparar:

- CONTROL, PARO y NAO (fase 1) y
- CONTROL, PARO y PERRO (fase 2).

Las sesiones terapéuticas se llevaron a cabo durante 1 hora, 2 días a la semana, durante tres meses.

Las evaluaciones, basal y de seguimiento, se llevaron a cabo por evaluadores ciegos a la terapia usando las siguientes escalas: Escala de Deterioro Global de la Demencia de Reisberg (GDS), Mini Examen Cognoscitivo Grave (sMMSE), Mini Examen Cognoscitivo (MMSE), Inventario Neuropsiquiátrico (NPI), Escala de Apatía para pacientes con demencia institucionalizados versión residencia (APADEM-NH) y Escala de Calidad de Vida (QUALID). También se recogieron datos sociodemográficos, así como el tratamiento farmacológico de acción psicoactiva.

El análisis estadístico incluyó estadística descriptiva y test no paramétricos realizados por un investigador ciego a la terapia.

Resultados:

Participaron 101 personas con demencia en la fase 1, y 110 en la fase 2. No hubo diferencias significativas en la evaluación basal, salvo en el ítem irritabilidad en la fase 2. En la evaluación de seguimiento los hallazgos más relevantes fueron:

Fase 1: Los participantes del grupo de NAO mostraron un descenso en las puntuaciones del test MMSE (empeoramiento), pero no en el test sMMSE, y un aumento en delirios (empeoramiento). Las personas con demencia en ambos grupos robots mostraron una tendencia a la mejoría en apatía. Los dos grupos donde se aplicaron los robots no mostraron diferencias significativas entre ellos.

Fase 2: Las puntuaciones en los ítems de alucinaciones, desinhibición e irritabilidad de la escala NPI aumentaron en el grupo PARO (empeoramiento) así como el ítem de irritabilidad en el grupo PERRO. En el grupo PARO, se observó una tendencia al empeoramiento de la calidad de vida y una mejoría en los trastornos del comportamiento nocturno.

La mayoría de los participantes no cambiaron de tratamiento psicoactivo durante el estudio.

Conclusiones:

De acuerdo con los resultados obtenidos en el presente estudio, las conclusiones son las siguientes:

1. Los robots sociales y los animales utilizados en una muestra de personas con demencia avanzada institucionalizadas son bien aceptados y pueden ser fácilmente incluidos en el modelo de terapia ocupacional convencional, adaptándose al grado de afectación de la persona.

2. La utilización de robot humanoide, robot mascota y perro no indujo cambios significativos en los trastornos del comportamiento ni mejoría en la calidad de vida de los participantes. No obstante, la medicación psicoactiva prescrita se mantuvo prácticamente estable.

3. En la comparación del efecto de las terapias entre sí, robot mascota con robot humanoide y robot mascota con animal, las diferencias observadas entre los distintos grupos de terapia no llegaron a alcanzar significación estadística (salvo la mejoría de la desinhibición en el grupo animal respecto al grupo robot mascota).

4. Por tanto, en el momento actual y en base a los resultados del presente estudio, no hay evidencia que permita avalar la recomendación de usar sistemáticamente estas herramientas en la terapia ocupacional de las personas con demencia avanzada. Son necesarios estudios adicionales, con un mayor tamaño muestral y pacientes en fases menos graves de demencia, antes de descartar su utilidad para mejorar la calidad de vida y los trastornos del comportamiento en personas con deterioro cognitivo.

INTRODUCCIÓN

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Demencia

La demencia de origen neurodegenerativo es un síndrome crónico y progresivo caracterizado por el deterioro de la función cognitiva, más allá de lo que podría considerarse una consecuencia del envejecimiento normal, interfiriendo en las actividades diarias. La demencia afecta a la memoria, el pensamiento, la orientación, la comprensión, el cálculo, la capacidad de aprendizaje, el lenguaje y el juicio. La conciencia no se ve afectada. El deterioro de la función cognitiva suele ir acompañado, y en ocasiones es precedido, por el deterioro del control emocional, el comportamiento social o la motivación. Con el tiempo, las personas con demencia no son capaces de realizar correctamente las actividades básicas de la vida diaria como el mantenimiento de la higiene personal o la alimentación (1,2).

Signos y síntomas

Los signos y síntomas relacionados con la demencia se pueden entender en tres etapas de evolución (2):

1. **Etapa temprana:** a menudo pasa desapercibida, ya que el inicio es paulatino. Los síntomas más comunes incluyen: tendencia al olvido; pérdida de la noción del tiempo; desubicación espacial, incluso en lugares conocidos.
2. **Etapa intermedia:** a medida que la demencia evoluciona hacia la etapa intermedia, los signos y síntomas se vuelven más evidentes y más limitadores. En esta etapa las personas afectadas: empiezan a olvidar acontecimientos recientes, así como los nombres de las personas; se encuentran desubicadas en su propio hogar; tienen cada vez más dificultades para comunicarse; empiezan a necesitar ayuda con el aseo y cuidado personal; sufren cambios de comportamiento, por ejemplo, dan vueltas por la casa o repiten las mismas preguntas.

3. **Etapa tardía:** en la última etapa de la enfermedad, la dependencia y la inactividad son casi totales. Las alteraciones de la memoria son graves y los síntomas y signos físicos se hacen más evidentes. Los síntomas incluyen: una creciente desubicación en el tiempo y en el espacio; dificultades para reconocer a familiares y amigos; una necesidad cada vez mayor de ayuda para el cuidado personal; dificultades para caminar; alteraciones del comportamiento que pueden exacerbarse y desembocar en agresiones.

Existen escalas para determinar el grado de evolución de la demencia, siendo la Escala de Deterioro Global de Reisberg (GDS, Global Deterioration Scale) (3), una de las más utilizadas internacionalmente. Dicha escala estratifica el deterioro cognitivo en los siguientes estadios:

1. Ausencia de alteración cognitiva (individuo sin deterioro).
2. Disminución cognitiva muy leve (deterioro cognitivo subjetivo.).
3. Defecto cognitivo leve (deterioro cognitivo leve).
4. Defecto cognitivo moderado (demencia en estadio leve).
5. Defecto cognitivo moderado-grave (demencia en estadio moderado).
6. Defecto cognitivo grave (demencia en estadio moderadamente grave).
7. Defecto cognitivo muy grave (demencia en estadio grave).

La etapa temprana se correspondería con los hitos 3 y 4 de la escala GDS, la etapa intermedia con los hitos 5 y 6 y la etapa tardía con el hito 7.

Los síntomas neuropsiquiátricos son muy frecuentes en las personas con demencia. Por orden de prevalencia son: apatía (la padecen aproximadamente la mitad de los pacientes), depresión, agresividad, ansiedad, trastornos del sueño, irritabilidad, trastorno alimentario, comportamiento motor aberrante, delirio, desinhibición, alucinaciones y euforia (4). Estos síntomas influyen en la calidad de vida de la persona con demencia y de su cuidador (5). Aunque comúnmente se asume que la calidad de vida disminuye para las personas con demencia, varios estudios revisados sugieren que la calidad de vida percibida por la persona con demencia es mayor que la percibida por el cuidador profesional o el familiar y que varias intervenciones no farmacológicas pueden aumentar la calidad de vida (6). De hecho, las intervenciones no farmacológicas reducen la gravedad de dichos síntomas, mientras que las intervenciones farmacológicas proporcionan una eficacia modesta (6).

Diagnóstico

El diagnóstico de la demencia se realiza mediante una cuidadosa historia clínica y una exploración incluyendo la exploración neurológica. Para evaluar el estado mental se observa la apariencia y el nivel de conciencia de la persona, su comportamiento social y su estado de ánimo. Se realizan escalas breves de detección como el Mini Examen Cognoscitivo (MMSE) (7,8), se determina su habilidad para realizar las actividades de la vida diaria, así como las actividades instrumentales. Este estudio se complementa con test neuropsicológicos específicos para evaluar la función ejecutiva frontal, la atención, la memoria visuoespacial y episódica verbal, el lenguaje y el cálculo, así como sus habilidades de percepción y visuoespaciales (9). Por último es necesario realizar determinaciones sanguíneas y exploraciones de neuroimagen para determinar su etiología o proceso patológico.

Formas más comunes

Las formas, o causas, de la demencia neurodegenerativa son múltiples y diversas. La enfermedad de Alzheimer es la forma más común de demencia, se calcula que representa entre un 60% y un 70% de los casos. Otras formas frecuentes son: la demencia mixta (con un componente neurodegenerativo y vascular), la demencia por cuerpos de Lewy, la demencia en la Enfermedad de Parkinson y un grupo de enfermedades que pueden contribuir a la demencia frontotemporal. Los límites entre las distintas formas de demencia son difusos y frecuentemente coexisten formas mixtas (2,10).

Tasas de demencia

La demencia afecta a nivel mundial a unos 47,5 millones de personas, más que la población de España. Cada año se registran más de 7 millones de nuevos casos, un nuevo caso cada cuatro segundos. Se prevé que el número total de personas con demencia sea de 131 millones en 2050 (11) .

Coste de la demencia

La demencia conduce a mayores costes de cuidado a largo plazo para los gobiernos, comunidades, familias e individuos y a pérdidas en la productividad de las economías. En 2016, el coste de la atención de la demencia a nivel mundial fue de unos 818 mil millones de dólares estadounidenses. En 2018, el coste de cuidar a las personas con demencia en todo el mundo se ha estimado que alcanzará el billón (10^{12}) de dólares, un total que podría socavar el desarrollo social y económico a nivel mundial (11). En España, el coste social de la demencia en 2010 se ha estimado en 15 millones de euros (12).

La prestación de cuidados informales a personas con demencia tiene una importante carga emocional, incluyendo un impacto perjudicial en la salud física y mental de cuidadores. Una de cada cuatro personas que cuidan de personas con demencia padece depresión (13).

Tratamiento y atención

En la actualidad, no hay ningún tratamiento que pueda curar la demencia o revertir su evolución progresiva, si bien varios fármacos enlentecen su avance: donepecilo, galantamina, rivastigmina y memantina (14). Existen nuevos tratamientos que se encuentran en investigación (15). En la fase IV del ensayo clínico, es decir ya en el mercado, se sitúan los siguientes fármacos: AVP-923, carvedilol, ácido docosahexaenoico (DHA), ketasyn, prazosina, resveratrol, simvastatina y Souvenaid.

Otras intervenciones dirigidas a apoyar y mejorar la vida de las personas con demencia y de sus cuidadores y familiares son:

- diagnóstico precoz para un tratamiento adecuado,
- optimizar la salud, la cognición, la actividad y el bienestar,
- identificar y tratar otras enfermedades concomitantes,
- detectar y tratar los síntomas conductuales y psicológicos problemáticos,
- proporcionar información y apoyo a largo plazo a las personas con demencia y a sus cuidadores (2).

Tratamiento no farmacológico

La terapia no farmacológica se centra en potenciar las actividades mental, física y emocional de la persona con demencia. Dichas actuaciones tratan de mantener la capacidad funcional de la persona, procurando asegurar sus niveles de calidad de vida y autonomía.

En una revisión sistemática de la eficacia de la terapia no farmacológica (16), esta última alcanzó una recomendación en grado B (es decir, al menos moderada evidencia de que la medida es eficaz y los beneficios superan a los perjuicios). Dichos beneficios se centrarían en mejorar la cognición, las actividades de la vida diaria, el comportamiento, el estado anímico y la calidad de vida. Si bien es necesario realizar estudios clínicos aleatorizados para aportar mayor evidencia de su eficacia (17).

Animales en la terapia de personas con demencia

Frecuentemente y en el caso de las personas mayores, al problema que supone el deterioro cognitivo se le une el hecho de que viven solos. Un hecho social relacionado, que se ha venido produciendo de forma natural, es la convivencia de las personas mayores que viven solas con animales de compañía. Se ha observado que dicha convivencia (18):

- mejora la calidad de vida del anciano al disminuir el grado de soledad,
- proporciona quehaceres y tareas a las cuales debe prestar atención,

- propicia la interacción física, emocional, y cognitiva de la persona con el animal, y
- proporciona sensación de seguridad al anciano.

La interacción con animales o mascotas tiene los siguientes efectos (19–21):

- fisiológico: mejora los signos vitales,
- psicológico: relajación, disminución del malestar, mejora del humor y del desánimo,
- social: facilita la comunicación.

En una residencia de personas mayores los animales pueden aportar compañía, significado y bienestar a la persona, además de promover las relaciones con los demás residentes, con los profesionales o con los familiares que les visitan (22,23).

En 2006, el Instituto Nacional de Salud y Excelencia Clínica (National Institute for Health and Clinical Excellence, NICE) recomendó el uso de un programa de estimulación cognitiva para las personas con demencia, considerando la terapia con animales cuando ésta fuera posible (24).

Se han realizado estudios de terapia mediante el uso de animales para evaluar su impacto en el comportamiento social, en la agitación y en la agresividad de los pacientes con demencia. Existen en la literatura varias revisiones sobre dichos estudios que indican la necesidad de realizar nuevas investigaciones con un mayor número de usuarios y una metodología más clara y eficaz (25–31).

En la terapia con animales se han usado varios animales: perros, gatos, pájaros, caballos, delfines, conejos, lagartos y otros pequeños animales. Si bien los perros han sido los más usados por sus habilidades sociales y su capacidad de entrenamiento (29,32).

Estos estudios se han realizado con pequeños grupos de pacientes diagnosticados de demencia (de 6 a 36 personas) hasta 2009. En la actualidad existen estudios donde participaron 100 (33) o más personas (34), si bien cuando se inició este proyecto de investigación no era así. Además, la mayoría de los estudios eran comparaciones con el mismo grupo antes de la intervención, siendo pocos los estudios publicados con grupos control (31).

En los mismos, se puede observar que el diseño de la aplicación de la terapia con animales es muy distinto de un estudio a otro. En la mayoría de los casos, la sesión terapéutica consiste en la visita del animal durante un tiempo determinado (de 20 minutos a 3 horas) en sesiones diarias, semanales o quincenales durante un periodo de tratamiento de pocos días hasta 3 meses. No se han apreciado diferencias entre la presencia del animal residente o las visitas semanales del animal (35).

En cuanto a las variables recogidas en los distintos estudios, cabe decir que giran alrededor de la sintomatología psicológica y comportamental de la persona con demencia, si bien las escalas utilizadas para su cuantificación no coinciden entre estudios. Para esas tomas de datos se han utilizado desde listados de observaciones, cuantificaciones manuales de palabras o gestos de los pacientes tras su video-filmación hasta escalas neuropsiquiátricas validadas para la población a estudio.

Los resultados obtenidos en los citados estudios han demostrado un mejor comportamiento social en los pacientes durante la presencia del animal (36). En dicha mejora del comportamiento, se produce un aumento de la frecuencia del contacto físico y visual y de las sonrisas, con un aumento de la duración de las miradas y las sonrisas (34,37). Así mismo, se observa una disminución de la agresividad verbal y de la agitación, disminuyendo los problemas de comportamiento aunque sin implicar cambios en la necesidad de tratamiento farmacológico (28,38).

En los estudios en los que se ha tenido en cuenta la gravedad de la demencia, se ha hallado que la respuesta a la terapia con animales es independiente de la gravedad de la misma (36,38,39).

El uso de animales no siempre es posible

Sin embargo, no siempre es posible realizar terapia con animales.

Unas veces no se permite la entrada de animales en las residencias debido a razones de higiene y seguridad (posible fuente de alergias, infecciones, mordiscos y arañazos) (40). Otras veces es el coste del mantenimiento de dichos animales y la atención que requieren lo que imposibilita su presencia en las residencias (29,41). También el bienestar de los animales en ocasiones limita su uso en terapia, dado que las sesiones provocan cierto estrés en los animales (si bien no se observan cambios en su comportamiento, concentración o motivación) (42).

Robots sociales en la terapia de personas con demencia

Desde el año 2000, se han iniciado proyectos con el uso de robots sociales como sustitutos razonables de los animales en la terapia de personas que sufren demencia (37,43).

Los robots no comportan la responsabilidad ni la necesidad de instalaciones que requiere el empleo de un animal, y con sus sensores pueden responder a los cambios ambientales (movimientos, sonidos…) simulando una interacción con el paciente al igual que los anteriores (44). A su vez aportan la posibilidad de monitorizar a los pacientes y de realizar una interacción terapéutica a nivel cognitivo, a diferencia de la terapia animal (44). Además, los robots siempre responden, no deciden a quien atienden y a quién no (como puede hacer un animal) (45).

Más ventajas potenciales de la terapia con robot son la ausencia de efectos adversos (presentes en la terapia farmacológica) y la posibilidad de llevarla a cabo sin entrenamiento previo (al contrario que el resto de terapias como la musicoterapia, la terapia con animales…).

Broekens et al publicaron en 2009 (46) una revisión sistemática analizando la literatura existente sobre los efectos de los robots sociales en el cuidado de la salud de las personas mayores, sobretodo en la función de la compañía al paciente. Los principales resultados del análisis de dichos estudios son: a la mayoría de los ancianos les gustan los robots y la forma y el material que compone el robot influyen en su aceptación. También indican que el efecto de los robots y aportan mejoría en:

- la salud mediante el descenso de los niveles de estrés (midiendo las hormonas asociadas al estrés en orina) (47) y el aumento de la respuesta del sistema inmunitario (48),
- el humor (mediante cuestionarios y la evaluación de las expresiones faciales),
- el sentimiento de soledad (49),
- la comunicación (medida por la frecuencia de contacto con los robots y con la familia) (50,51),
- el recuerdo el pasado (sobre todo con un robot en forma de bebé),
- las escalas de gravedad de la demencia.

Respecto a los estudios que incluye, los autores de la revisión indican que:

- existen muy pocas publicaciones en revistas médicas, encontrándose la mayor parte en revistas de robótica o tecnología,
- la mayoría de las publicaciones indican efectos positivos en la salud y el bienestar psicológico de las personas mayores, aunque la evidencia de que dichos efectos sean atribuibles al robot es escasa, no pudiéndose excluir el efecto de variables de confusión,
- no existen estudios controlados aleatorizados,
- la metodología de los estudios no es robusta (no hay buenas condiciones de control y el efecto es muy pequeño al igual que el número de participantes como para extraer conclusiones),
- algunos estudios son contradictorios en sus resultados,
- su duración es demasiado corta para excluir el efecto de la novedad,
- bajo número de participantes (de 5 a 26),
- no se describen con suficiente detalle para ser replicados, y
- no se puede excluir el efecto Hawthorne (cambio temporal de comportamiento debido a un cambio en el ambiente).

En 2012, Bemelmans et al (52) revisaron nuevamente la literatura para estudiar los efectos y la eficacia de los robots sociales en el cuidado de las personas mayores. Incluyeron 41 publicaciones, describiendo 17 estudios. La mayoría de los estudios hallaron efectos positivos de los robots sociales: (socio)psicológicos (por ejemplo, humor, soledad, conexiones sociales y comunicación) y fisiológicos (por ejemplo, reducción del estrés). Si bien, como en la anterior revisión, indican que la calidad metodológica de los estudios fue en su mayoría baja, siendo el valor de la evidencia limitado.

Kachouie et al (53), dos años después, incluyeron 86 estudios con distintos robots, diseños, atributos, aplicaciones, escenarios, metodología...para revisar nuevamente la cuestión. Si bien las conclusiones fueron similares, recomendando el uso de una metodología más rigurosa, centrada en la persona y en su bienestar, y la comparación de distintos robots.

Mordoch et al en 2013 (54) se centraron en las personas mayores con demencia para hacer su revisión. Incluyeron sólo 21 artículos: 9 de revistas científicas y 12 ponencias a congresos. Los autores indican que empieza a haber evidencia de que los robots en terapia son útiles para fomentar que las personas interactúen entre ellas, para calmar o aportar compañía, motivación y disfrute. E inciden nuevamente en que: los estudios realizados no son robustos (muestras pequeñas, falta de grupo control, dificultad de réplica…), es necesario realizar ensayos clínicos aleatorizados para determinar el efecto terapéutico de la interacción con el robot y se deberían publicar en revistas con revisión por pares.

Experiencia del equipo investigador sobre el tema

El equipo investigador que ha llevado a cabo el estudio que se describirá a continuación es un equipo multidisciplinar, con amplia experiencia en la asistencia e investigación de los trastornos cognitivos, en la evaluación de personas con demencia y en el análisis de resultados, así como en la programación y uso de los robots.

Miembros del equipo investigador han participado en:

- estudios para identificar el estado actual en la investigación del envejecimiento a nivel europeo y de la Enfermedad de Alzheimer en nuestro país, así como conocer la prevalencia real de la enfermedad y del resto de demencias (55),
- la evaluación de déficit, discapacidad y calidad de vida de pacientes con enfermedad neurodegenerativa y demencia institucionalizadas (56, 57), así como en la creación de nuevas escalas para determinar y cuantificar la existencia de trastornos de conducta en dichos colectivos y que se aplicarán para valorar el efecto terapéutico en el presente proyecto (58),
- el desarrollo de un sistema de detección de caídas orientado a facilitar la vida autónoma de personas mayores (59) (realizado por el grupo de robótica de la Universidad Rey Juan Carlos (URJC) el cual desarrolla software para NAO participando en competiciones como la RoboCup).

Los estudios sobre el uso de los robots sociales en la terapia de personas mayores son posteriores al año 2000, indicando la novedad de esta área de investigación (46).

La mayoría de los estudios que se realizaron antes de iniciar este proyecto se llevaron a cabo en Japón, sureste asiático y E.E.U.U. (sociedades donde el uso de robots está más expandido). Si bien empezaba a utilizarse dicha tecnología en Europa con buena aceptación de los robots, a pesar de no ser tan habituales en dichas culturas.

En 2009 no se hallaron en la literatura proyectos con el uso de robots sociales en el tratamiento de la demencia en España. Por este motivo, este estudio pretendía aportar evidencia sobre los posibles beneficios del uso de robots con respecto a factores propios a nivel nacional como pueden ser el tipo de terapia que se lleva a cabo en las residencias del Sistema Nacional de Salud, factores culturales propios de nuestro país en relación con la tecnología…

Por tanto, este proyecto fue innovador desde el punto de vista de aplicación de tecnologías para el tratamiento de la demencia en España. Dada su novedad, no se contaba con experiencia directa previa. Por ello, se decidió realizar una experiencia piloto de viabilidad, para determinar la aceptación de los robots por parte de las personas con demencia del Centro Alzheimer Fundación Reina Sofía (CAFRS).

Estudio de viabilidad

En 2010, se introdujo un robot NAO en las sesiones de terapia cognitiva y de fisioterapia de un grupo de personas diagnosticadas de demencia tipo Alzheimer con el objetivo de determinar si se observaba algún cambio en su sintomatología neuropsiquiátrica o en su calidad de vida.

Los participantes fueron personas con demencia tipo Alzheimer del Centro de día de la Fundación Reina Sofía, que previamente recibieron información del estudio y firmaron el Consentimiento Informado aprobado por el Comité de Ética. Las sesiones tuvieron lugar dos veces a la semana durante un mes.

Las evaluaciones se realizaron antes y después de la intervención y se utilizaron las siguientes escalas:

- Escala de Deterioro Global de Reisberg (GDS) (3)
- Inventario Neuropsiquiátrico (NPI) (60–62)
- Escala de Apatía para pacientes con demencia institucionalizados – versión residencia (APADEM-NH) (58) y
- Escala de Calidad de Vida QUALID (63,64).

Participaron 13 personas diagnosticadas de demencia tipo Alzheimer en grado moderado-grave (GDS 4: 23%, GDS 5: 31% y GDS 6: 46%), siendo su edad media de 83 años (rango de edad de 74 a 91 años) y en su mayoría mujeres (92%). En la evaluación de seguimiento no se observaron cambios en la gravedad de los participantes.

En el inventario neuropsiquiátrico se observó un descenso en la puntuación media de la escala, es decir una menor gravedad y frecuencia de dichos síntomas, y los siguientes cambios en la media de los ítems (ver tabla 1):

- un descenso en aspectos como: alucinaciones, apatía, desinhibición, irritabilidad, movimiento errático y trastornos de la alimentación, y
- un aumento en: delirios, la agitación, la depresión y el sueño, aumentando también la frecuencia de la ansiedad.

En el Inventario de Apatía, tras la intervención se observó un descenso en la puntuación global, es decir, una mejoría en la apatía, y en los tres ítems de la escala: el aplanamiento emocional, la falta de iniciativa y la falta de interés. Aplicando la escala de apatía APADEM-NH se observó también un descenso global, es decir, una mejoría en la apatía, y en sus tres dominios: conducta autogenerada, aplanamiento afectivo e inercia cognitiva (ver tabla 1).

En cuanto a la calidad de vida de los participantes, también se apreció un ligero descenso del total y en la mayoría de los ítems, es decir mejoría de la misma (ver tabla 1).

El tamaño de muestra de este estudio piloto fue demasiado pequeño para observar diferencias estadísticamente significativas, pero se observó una tendencia a la reducción de algunos síntomas neuropsiquiátricos como la apatía, la agresividad, las alucinaciones y los trastornos alimentarios, así como una tendencia a la mejora de la tristeza, el malestar o la infelicidad.

El tratamiento farmacológico fue controlado, permaneciendo estable en la mayoría de los usuarios, salvo en dos personas: la primera inició tratamiento hipnótico con lorazepam (0,5 mg/noche); y la segunda cambió el tratamiento de quetiapina 25 mg/d, paroxetina 20 mg/d y bromazepam 1,5 mg/d por paroxetina 10 mg/d y trazodona 75 mg/d.

Además, sin contar con un grupo control que recibiera las mismas atenciones que el grupo experimental excepto el robot, y con un tiempo de intervención tan breve es imposible descartar que las observaciones fueran producto del efecto Hawthorne.

Este pequeño estudio permitió determinar la viabilidad del estudio y la buena acogida de los robots en un grupo de personas con demencia del CAFRS.

VARIABLES (ESTUDIO VIABILIDAD)	BASAL	SD	FINAL	SD	CAMBIO	SD	P
QUALID	21,69	8,78	20,46	8,34	-1,23	8,47	0,777
IA	13,69	11,00	10,38	11,64	-3,31	12,00	0,274
aplanamiento	3,00	4,42	1,31	3,40	-1,69	3,92	0,107
falta de iniciativa	5,08	4,05	4,46	4,89	-0,62	4,81	0,289
falta de interés	5,62	3,91	4,62	4,81	-1,00	4,65	0,336
APADEM-NH	14,23	8,86	9,77	10,26	-4,46	11,13	0,233
déficit pensamiento	6,00	3,67	3,46	4,45	-2,54	4,93	0,099
aplanamiento emocional	3,23	2,55	1,92	2,50	-1,31	3,28	0,170
inercia cognitiva	5,00	3,58	4,38	3,91	-0,62	4,11	0,832
NPI	14,46	14,69	10,38	9,19	-4,08	13,20	0,234
delirios	1,85	3,39	2,00	3,46	0,15	4,60	0,939
alucinaciones	0,69	2,50	0,00	0,00	-0,69	2,50	0,317
agitación	1,31	2,02	1,69	1,38	0,38	1,39	0,294
depresión	0,77	1,17	1,38	1,61	0,62	1,33	0,057
ansiedad	1,08	1,89	0,92	1,19	-0,15	1,95	0,913
euforia	0,08	0,28	0,08	0,28	0,00	0,41	1,000
apatía	2,00	2,48	0,62	2,22	-1,38	3,71	0,065
desinhibición	0,85	1,77	0,08	0,28	-0,77	1,83	0,158
irritabilidad	2,23	3,37	1,62	2,69	-0,62	3,97	0,800
movimiento errático	1,08	1,89	0,46	1,20	-0,62	1,19	**0,046**
sueño	0,38	1,12	0,46	1,20	0,08	1,75	0,966
alimentación	2,15	3,78	1,08	3,33	-1,08	3,71	0,319

Tabla 1: Resultados del estudio de viabilidad. Media de la puntuación basal (BASAL), final (FINAL) y del cambio (CAMBIO) con sus desviaciones estándar (SD) y valor de P para todas las variables del estudio de viabilidad. En negrita aparecen los valores de p<0,05.

HIPÓTESIS Y OBJETIVOS

HIPÓTESIS

Este trabajo trató de validar, en un centro donde reciben atención multidisciplinar pacientes con enfermedad de Alzheimer y otras demencias, las siguientes hipótesis:

- los robots sociales y los animales pueden:
    - ser aceptados por personas con demencia institucionalizadas en España, e incluirse en el modelo de terapia ocupacional que se utiliza actualmente en los pacientes con demencia, adaptándose al grado de afectación de la persona,
    - mejorar el comportamiento del paciente, permitiendo así mantener o reducir la medicación indicada para dichos trastornos conductuales
    - aportar una mejoría en la calidad de vida,
- el robot social humanoide mejorará más los trastornos del comportamiento y la calidad de vida respecto a un robot mascota, por el uso del lenguaje oral, su mayor movilidad y la mayor interacción
- los animales mejorarán más los trastornos del comportamiento y la calidad de vida respecto a los robots mascota, por su mayor interacción

OBJETIVOS

El objetivo primario del proyecto fue la comparación de una terapia basada en la utilización de robots sociales o animales frente a la terapia ocupacional habitual, en relación a:

- las alteraciones de comportamiento y su necesidad de medicación, y
- la calidad de vida

Los objetivos secundarios del proyecto fueron:

- la comparación del efecto de las terapias entre sí (robot mascota con robot humanoide y robot mascota con animal), y
- la optimización de las sesiones terapéuticas para investigaciones adicionales y/o implantación.

MATERIAL Y MÉTODOS

MATERIAL Y MÉTODOS

Diseño del estudio

Se diseñó como un estudio exploratorio controlado de grupos paralelos, aleatorizado por bloques y estratificado por la gravedad de la demencia, comparando la terapia con robots sociales (robot humanoide NAO y robot mascota PARO) y perros entre ellas y con las terapias habituales (ver figura 1).

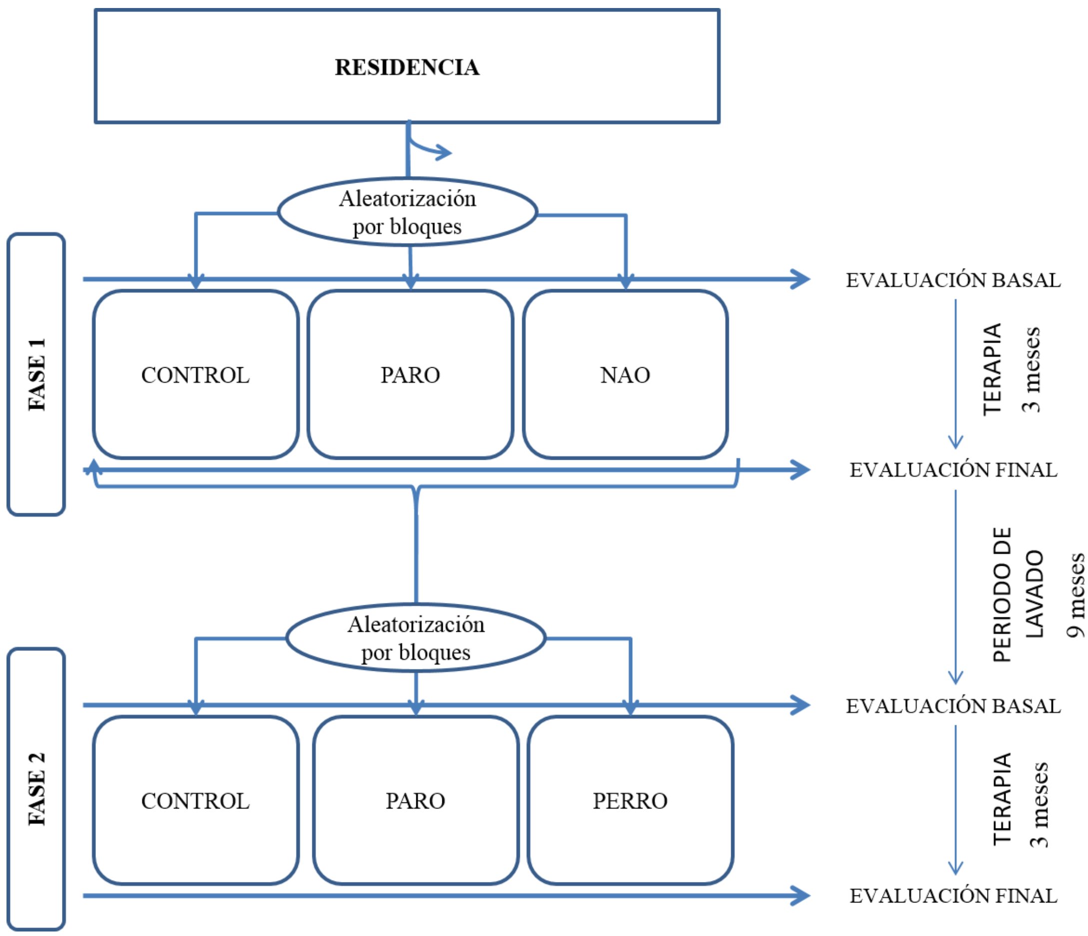

Figura 1: Diagrama de flujo del estudio. Todos los participantes firmaron el consentimiento (sus responsables legales) y superaron los criterios de inclusión/exclusión. Cada grupo trabajó con una herramienta (habitual o CONTROL, PARO, NAO o PERRO), y fue evaluado antes y después de las sesiones del estudio. El periodo de lavado permitió la entrada de nuevos participantes. Los participantes fueron aleatorizados en dos ocasiones: tras su inclusión en el estudio y tras la inclusión de nuevos participantes durante el periodo de lavado

Población

Todas las personas con demencia del CAFRS, una residencia pública de la Comunidad de Madrid, fueron invitadas a participar en el estudio. En la residencia viven 156 personas diagnosticadas de demencia de tipo neurodegenerativo. El diagnóstico de demencia se realiza antes del ingreso mediante los criterios del DSM IV (Manual de Diagnóstico y Estadística de las Enfermedades Mentales, Diagnostic and Statistical Manual of Mental Disorders) (1), por un médico especialista en geriatría ajeno al estudio. Se trata de un centro dedicado a personas con demencia neurodegenerativa siendo descartadas al ingreso las personas con demencia de causa no degenerativa (vascular, postraumática…).

Aspectos éticos

Todos los participantes, sus representantes legales o sus guardadores de hecho, recibieron información del estudio y firmaron el consentimiento informado aprobado por el Comité de Ética de la FCIEN.

Todos los datos personales se utilizaron con absoluta confidencialidad, de acuerdo con la legislación vigente sobre protección de datos personales así como sobre el derecho a la rectificación y la cancelación de los mismos: Ley de Protección de Datos (15/1999 de 13 de diciembre), Ley de Investigación Biomédica (14/2007 de 3 de julio) y Ley Reguladora de la Autonomía del Paciente (41/2002 de 14 de noviembre).

Criterios de inclusión

Los criterios de inclusión que fueron aplicados a los candidatos a participantes en este estudio fueron: estar diagnosticados de demencia neurodegenerativa, estar ingresado en la residencia del CAFRS y haber firmado el consentimiento informado.

Criterios de exclusión

Los criterios de exclusión aplicados a los mismos candidatos fueron: tener alergia o miedo al robot o al perro o bien padecer una enfermedad aguda grave (que requiriera hospitalización o cuidados intensivos).

Tamaño muestral

No se realizó una estimación del tamaño de la muestra por tratarse de un estudio exploratorio.

Grupos de estudio

El estudio tuvo dos fases de un año de duración cada una, siendo años consecutivos (2012 y 2013). Las herramientas a comparar fueron:

- Fase 1: CONTROL, PARO, NAO
- Fase 2: CONTROL, PARO, PERRO

Todos los participantes fueron asignados a un único grupo terapéutico y trabajaron con sólo una herramienta (CONTROL, PARO, NAO o PERRO) siendo evaluados antes y después de las sesiones del estudio.

Distribución de los participantes

Los residentes se distribuyen en nueve unidades de vida o edificios de similares características. La distribución de las personas con demencia en los edificios se realiza por la gravedad del síndrome a su ingreso. Así, las personas que ingresan con demencia leve-moderada ingresarán en los tres primeros edificios (resaltadas en verde en la figura 2), las que padecen demencia moderada-grave lo harán en las siguientes tres unidades (en azul en la fotografía) y quienes ingresan con demencia grave o muy grave, o se deterioran estando en la residencia, ocuparán las camas de los últimos tres edificios (en naranja).

Figura 2: Distribución de los participantes según gravedad. En esta fotografía aérea se aprecian los nueve edificios o unidades de vida coloreados según la gravedad de la demencia de las personas que en ellos residen: verde para la demencia leve-moderada, azul para la demencia moderada-grave y naranja para la demencia grave-muy grave.

Antes de iniciar el proyecto se planteó la posibilidad de: cambiar los residentes de habitación según el resultado de la distribución aleatoria de los participantes (aleatorización anual), o bien desplazar a los residentes a otro espacio común para realizar la terapia (dos veces por semana durante tres meses). Ambas posibilidades se desestimaron por suponer un inconveniente para algunos de los residentes (agrupaciones familiares o dificultad para el desplazamiento).

Se optó por asignar aleatoriamente una de las herramientas a estudio a cada uno de los edificios de la triada con similar gravedad de la demencia (aleatorización por bloques). Por ejemplo, en los tres edificios 'naranjas' donde residen personas con demencia grave-muy grave se utilizaron las herramientas habituales en uno de ellos (CONTROL), una de las herramientas a estudio en otro (HERRAMIENTA 1) y otra herramienta de estudio en el último (HERRAMIENTA 2).

Todos los residentes reciben un cuidado similar: atención médica, terapia no farmacológica, nutrición personalizada, ejercicio físico, fisioterapia… Se controlaron las condiciones ambientales de los usuarios de forma que fueran similares en todos los edificios, siendo la herramienta empleada por el terapeuta el único elemento diferencial entre los grupos.

La aleatorización se realizó antes de la evaluación basal mediante un dado de 6 caras que se tiró una vez por cada grupo de gravedad (demencia leve-moderada, moderada-grave y grave-muy grave). Antes de tirar el dado se definió el valor de los grupos y de HERRAMIENTA 1 (en la fase 1: NAO y en la fase 2: PERRO) y de HERRAMIENTA 2 (PARO), siendo la posibilidad de distribución de los grupos de estudio (ver tabla 2):

RESULTADO	GRUPO 1	GRUPO 2	GRUPO 3
1	CONTROL	HERRAMIENTA 1	HERRAMIENTA 2
2	CONTROL	HERRAMIENTA 2	HERRAMIENTA 1
3	HERRAMIENTA 1	CONTROL	HERRAMIENTA 2
4	HERRAMIENTA 2	CONTROL	HERRAMIENTA 1
5	HERRAMIENTA 1	HERRAMIENTA 2	CONTROL
6	HERRAMIENTA 2	HERRAMIENTA 1	CONTROL

Tabla 2: Posibles resultados del dado en la aleatorización de los grupos terapéuticos.

Herramientas utilizadas

Las herramientas utilizadas en el estudio fueron:

PARO

Es un robot social con la apariencia, el movimiento y los sonidos de una cría de foca (ver figura 3). Su comportamiento no es programable y dispone de sensores de tacto, postura, movimiento, sonido y luz.

Figura 3: Fotografía del robot social PARO. En la imagen aparece con el peto usado en la terapia. Este peto permitía pegar con velcro imágenes o tejidos de distintas texturas y colores, así como contener objetos en sus amplios bolsillos.

Sus ojos se abren y se cierran, son grandes, negros y tienen unas grandes pestañas. Puede mover el cuello (lateralmente y de arriba abajo), las patas delanteras y la cola. Si bien sus movimientos son silenciosos, vocaliza de forma corta y aguda como una cría de foca real. Es muy suave y blanca, y su funda tiene un velcro fuerte en el acceso al mecanismo (siendo difícil su apertura durante las sesiones). No se desplaza ni cabe la posibilidad de modificar sus vocalizaciones. Su peso es de 2,7 kg.

NAO

Es un robot social humanoide blanco que mide 58 centímetros y pesa 4,3 kg (ver figura 4).

Tiene sensores de movimiento, postura, distancia, tacto, sonido y luz. Puede mover el cuello y las extremidades, incluso andar y bailar.

Se desarrolló software para poder realizar las sesiones de terapia diseñadas, incluyendo habla, música y movimiento.

Figura 4: Fotografía del robot social NAO. El robot lleva aplicaciones con tejidos de distintas texturas y colores.

Además se modificó la voz del robot y la velocidad de sus movimientos. La voz sintética era de difícil comprensión para las personas mayores, así que se reemplazó por grabaciones mp3 de una terapeuta con voz blanca. Los movimientos del robot eran demasiado lentos, así que se aceleró el ritmo para mantener la atención de los usuarios.

Durante las sesiones terapéuticas, un ingeniero controlaba el robot desde un ordenador mediante una red inalámbrica (wifi) siguiendo las instrucciones del terapeuta. Posteriormente, se programó un dispositivo electrónico a modo de control remoto para permitir que el terapeuta llevara a cabo la sesión terapéutica de forma autónoma. En un principio se utilizó una tableta en la que venían especificadas en un menú las distintas partes de la sesión terapéutica. De esta manera, el terapeuta podía elegir qué ejercicio iniciar, repetir u omitir. Posteriormente se añadió un mando de consola Wii para permitir el control motor del robot por la sala de terapia. Pero el uso de dicho mando distraía a los usuarios y a los terapeutas. Por ello, se decidió incluir el control motor del robot en la aplicación de la tableta. Finalmente, se optó por utilizar un teléfono inteligente o smartphone en lugar de una tableta, dado que permitía guardarlo rápidamente en un bolsillo si era necesario el uso de ambas manos, como por ejemplo, para ayudar a un usuario a levantarse.

LABRADOR RETRIEVERS ADULTOS:

Los animales usados en el estudio fueron dos perros que previamente habían recibido entrenamiento para terapia (ver figura 5).

Figura 5: Fotografía de un perro *Labrador retriever* adulto.

Cada perro participó en la mitad de las sesiones de cada grupo de terapia con animales, para así tratar de reducir el sesgo que podría introducir el distinto carácter o comportamiento de cada uno de los animales.

Los terapeutas recibieron entrenamiento para el manejo de los animales antes de las sesiones de terapia. Los animales acudieron en varias ocasiones al centro para familiarizarse con los espacios y el personal antes del inicio de su participación en las sesiones, si bien no contactaron con la población diana del estudio ni con sus cuidadores. Los terapeutas que entrenaban a los animales acudieron a todas las sesiones para monitorizar el curso de la terapia, si bien no participaron en ésta. Los cuidadores no pudieron interaccionar con los animales.

Adecuación de las herramientas utilizadas

Las herramientas que se usaron en el grupo control fueron las mismas que las usadas en los otros grupos, si bien algunas de ellas se adaptaron para el uso en los tres grupos.

Los robots y los animales llevaban chalecos que se diseñaron y cosieron expresamente para este proyecto con velcro y bolsillos para poder moverse de participante a participante llevando pequeños objetos (peines, pañuelos, bolsas de frío y calor….) o permitir pegar y despegar distintas fichas a lo largo de la sesión (imágenes, letras, números, telas de texturas y colores distintos…).

Terapia

Las sesiones de terapia tuvieron una duración aproximada de 1 hora y se llevaron a cabo dos días a la semana durante tres meses.

Características de las sesiones de terapia

Todas las sesiones se llevaron a cabo siguiendo sus características habituales: el mismo terapeuta, la misma estructura, el mismo horario y la misma duración.

En cada sesión se utilizó una única herramienta: un robot o un perro.

Los participantes interaccionaron con los robots, los animales y los terapeutas para llevar a cabo distintas actividades: identificación de números, letras o colores mediante fichas; práctica en el uso de objetos de la rutina diaria como peines, cepillos…; ejercicios de estimulación sensorial mediante el uso de telas con distinto tacto…

Todas las sesiones de terapia fueron grabadas en vídeo para su análisis posterior. Para ello, dos cámaras con trípode fueron dispuestas en el exterior del círculo para grabar de forma cruzada. Se realizaron varias sesiones con cámaras antes del inicio del proyecto para que los terapeutas y los usuarios se acostumbraran a su presencia y así reducir el efecto Hawthorne.

Estructura de las sesiones de terapia

Todas las sesiones siguieron la estructura habitual:

1. **Preparación de las sesiones**

Antes de iniciar la sesión se cargaban las baterías de los robots sociales y se comprobaba su correcto funcionamiento para evitar la aparición de errores u omisiones a lo largo de los ejercicios. La higiene de los robots se realizó mediante vinagre de limpieza que higieniza pero no es tóxico al tacto o ingestión en cantidades mínimas.

2. **Introducción**

Bienvenida al grupo, presentación de la herramienta, actividades de orientación (temporal, espacial y en persona), así como motivación para participar de forma activa en la sesión.

3. **Ejercicios**

Actividades enfocadas a la estimulación de: la memoria, el lenguaje, el cálculo, el movimiento, las praxias y el uso de los sentidos. Las actividades incluían ejercicio físico, preguntas y respuestas, música y manipulación de distintos objetos. Entre las distintas actividades se realizaron varias pausas para fomentar la colaboración y la participación de todos los usuarios.

4. **Despedida**

Repaso de las actividades realizadas, breve encuesta para saber si la sesión había sido del agrado de los participantes, si querían repetir la experiencia y su estado anímico, así como canción de despedida.

Tipos de sesiones terapéuticas según la gravedad de la demencia

Los terapeutas se encargaron de diseñar y adaptar las sesiones terapéuticas de las personas con demencia para este estudio. No obstante, en este proyecto no se modificó el modelo de terapia habitual del centro, sino únicamente se introdujeron las herramientas como un elemento más de la terapia. Para ello, los terapeutas recibieron unas mínimas instrucciones para la implantación y los posibles usos de los robots y los animales, dado que era la primera vez que los utilizaban.

Es importante remarcar que el objetivo fue comparar el efecto de las herramientas, así que éstas se usaron para un mismo fin y de una manera similar en los tres grupos terapéuticos, dentro de lo posible.

Además, se realizaron guiones de las sesiones para homogeneizar su contenido entre sesiones y entre terapeutas.

Finalmente, se diseñaron tres tipos de sesiones con distinto grado de dificultad dirigidas a personas con:

- **Demencia leve-moderada**.

  Se diseñaron tres sesiones: terapia con música, terapia cognitiva y fisioterapia. En este colectivo, las sesiones se realizaron en grupos de 9 a 15 personas en círculo con el terapeuta y sus herramientas situados en la parte central.

- **Demencia moderada-grave**.

  Se diseñaron dos sesiones: una sesión cognitiva (con música) y una sesión de fisioterapia. Las personas con demencia moderada-grave requieren terapia individualizada, si bien se intenta promover la interacción con otras personas o con el terapeuta. En las sesiones individuales el terapeuta se sentaba justo enfrente de la persona, al mismo nivel, proporcionando los estímulos de uno en uno.

- **Demencia grave**.

  Se diseñó una única sesión para estimular la respuesta (verbal o no verbal) con el uso del lenguaje, de la música, movimientos pasivos y estimulación sensorial (sonidos, luces y texturas).

Es de destacar que las herramientas del estudio fueron usadas siguiendo el modelo de terapia ocupacional, adaptándose al grado de afectación de los usuarios.

Terapeutas

Los terapeutas fueron los mismos terapeutas ocupacionales, fisioterapeutas y neuropsicólogos trabajadores del CAFRS.

Los terapeutas especializados en la terapia con animales y los ingenieros no participaron en la terapia, sólo monitorizaron las sesiones desde una esquina de la sala (fuera del campo visual de los participantes y los terapeutas).

Las herramientas del estudio no sustituyeron al terapeuta, sino que fueron una herramienta del terapeuta.

Evaluación

Las evaluaciones tuvieron lugar antes y después de las sesiones de terapia del estudio. En un principio se había diseñado una evaluación intermedia y otra de seguimiento, pero se tuvo que prescindir de dichas evaluaciones dada la falta de personal y financiación para llevarlas a cabo.

Variables analizadas

Las escalas utilizadas en este estudio fueron escalas estandarizadas, validadas para la muestra a estudio e internacionales para permitir la replicación o su comparación con otros estudios a nivel internacional (ver tabla 3).

La **Escala de Deterioro Global de Reisberg** (the Global Deterioration Scale, GDS) (3) permite determinar la fase evolutiva de la enfermedad evaluando el grado de deterioro cognitivo. Su puntuación es de 0 a 7, siendo esta última la de mayor deterioro. Fue administrada por un neurólogo.

El **Mini Examen Cognoscitivo para pacientes graves** (the Severe Mini Mental State Examination, sMMSE) (65,66) y el **Mini Examen Cognoscitivo** (the Mini Mental State Examination, MMSE) (7,8) fueron aplicados por psicólogos.

El Mini Examen Cognoscitivo es un cuestionario de 30 preguntas donde se evalúa: orientación espacio temporal, capacidad de atención, concentración y memoria, capacidad de abstracción (cálculo), capacidad de lenguaje y percepción visuoespacial y capacidad para seguir instrucciones básicas. Su rango de puntuaciones es de 0 a 30, indicando el 0 un mayor deterioro cognitivo.

El Mini Examen Cognoscitivo para pacientes graves es un instrumento de evaluación del deterioro cognitivo avanzado que amplía el rango inferior de medida del MMSE evitando el «efecto suelo». Su rango de puntuaciones también es de 0 a 30, indicando el 0 un mayor deterioro cognitivo.

El **Inventario Neuropsiquiátrico** (the Neuropsychiatric Inventory, NPI) (60–62) y la **Escala de Apatía para pacientes con demencia institucionalizados – versión residencia** (the Apathy Scale for Institutionalized Patients with Dementia - Nursing Home Version, APADEM-NH) (58) fueron administrados por un psiquiatra.

El Inventario Neuropsiquiátrico es un cuestionario cumplimentado por el cuidador, en nuestro caso aplicado por un psiquiatra al cuidador formal. Esta escala permite preguntar síntoma a síntoma los 12 trastornos del comportamiento más frecuentes de las personas con demencia: apatía, depresión, agresividad, ansiedad, trastornos del sueño, irritabilidad, trastorno alimentario, comportamiento motor aberrante, delirio, desinhibición, alucinaciones y euforia. Cada síntoma es un ítem y se recoge su frecuencia y gravedad, siendo el rango de cada uno de los ítems de 0 a 12. La puntuación total de la escala es la suma de ellos, siendo su rango de 0 a 144, indicando mayor sintomatología neuropsiquiátrica a medida que aumenta su valor.

La escala APADEM-NH, una herramienta desarrollada en el CAFRS, tiene la ventaja de medir la apatía de forma precisa independientemente del grado de demencia o depresión del participante. Esta escala evalúa el déficit de pensamiento y de conductas autogeneradas, el aplanamiento emocional afectivo y la inercia cognitiva mediante preguntas que se puntúan según la respuesta al estímulo en una escala tipo Likert con cuatro opciones de respuesta 0 (sin afectación) a 3 (grave). El rango de puntuaciones es de 0 (sin apatía) a 81 (apatía grave).

La **Escala de Calidad de Vida en Demencia Avanzada** (the Quality Of Life In Late-Stage Dementia, QUALID), (63,64) fue creada específicamente para personas con demencia grave institucionalizadas y se basa en la información que proporciona el cuidador profesional. En nuestro caso fue aplicada por un sociólogo a los cuidadores profesionales. Tiene 11 ítems referidos a comportamientos observables: sonreír, llorar, parecer triste, molesto, irritable o tranquilo, disfrutar comiendo, tocando o interactuando con los demás. Los ítems se puntúan como frecuencia de aparición en una escala

Likert con cinco opciones de respuesta. La puntuación total de la escala varía de 11 (mejor CV) a 55 (peor CV).

EVALUADOR	ESCALA
Neurólogo	Escala de Deterioro Global de Reisberg (GDS)
Psicólogo	Mini Examen Cognoscitivo para pacientes graves (sMMSE) Mini Examen Cognoscitivo (MMSE)
Psiquiatra	Inventario Neuropsiquiátrico (NPI)
	Escala de Apatía para pacientes con demencia institucionalizados – versión residencia (APADEM-NH)
Sociólogo	Escala de Calidad de Vida en Demencia Avanzada (QUALID)

Tabla 3: Variables del estudio. Tabla resumen de las escalas utilizadas en el estudio y el evaluador que las aplicó.

También se recogieron datos sociodemográficos, así como el tratamiento farmacológico de acción psicoactiva. La medicación fue prescrita y revisada de forma continua, sin restricciones por parte del estudio, por el médico especialista en geriatría del CAFRS (ajeno a esta investigación).

Las sesiones fueron grabadas en vídeo para su posterior análisis mediante listados de observaciones por dos investigadores.

Evaluadores

La evaluación se llevó a cabo por los profesionales de la FCIEN y del CAFRS que están entrenados y tienen experiencia en la aplicación de las escalas del estudio.

Los evaluadores fueron ciegos a la herramienta utilizada en la terapia.

Cuando las evaluaciones requirieron la entrevista con un cuidador, los evaluadores trataron, dentro de lo posible, de entrevistar siempre al mismo cuidador.

Ubicación

Este proyecto se realizó en tres centros: la Fundación CIEN (FCIEN), el CAFRS y la URJC.

En la FCIEN tuvo lugar: la coordinación, el reclutamiento de los participantes, la preparación y cumplimentación del cuaderno de recogida de datos y de la base de datos, la aleatorización, el análisis de datos y la publicación de los resultados.

En la residencia del CAFRS se realizaron las siguientes tareas: la preparación de las sesiones, las sesiones terapéuticas y las evaluaciones.

En el Laboratorio de Robótica de la URJC se llevó a cabo la preparación del robot NAO.

Periodo del estudio

El estudio se realizó en dos fases, de un año de duración cada una, en los años 2012 y 2013.

Cronograma

Este proyecto tuvo una duración de tres años. Durante el primer año del estudio se llevaron a cabo: el reclutamiento de la muestra, la preparación y prueba de las sesiones, la preparación de los cuadernos de recogida de datos y de la base de datos, la adquisición y preparación del robot NAO, la aleatorización, las grabaciones y las evaluaciones. Durante el segundo y tercer año se realizaron la fase 1 y 2 del estudio, respectivamente.

Las evaluaciones y sesiones terapéuticas no se pudieron realizar simultáneamente a toda la muestra debido a la escasez de evaluadores, por lo que se prolongó el estudio en el tiempo agrupando las unidades de vida. De esta manera los evaluadores tenían que evaluar un menor número de personas por mes, si bien cada una de las evaluaciones del estudio se prolongaba en el tiempo (ver tabla 4).

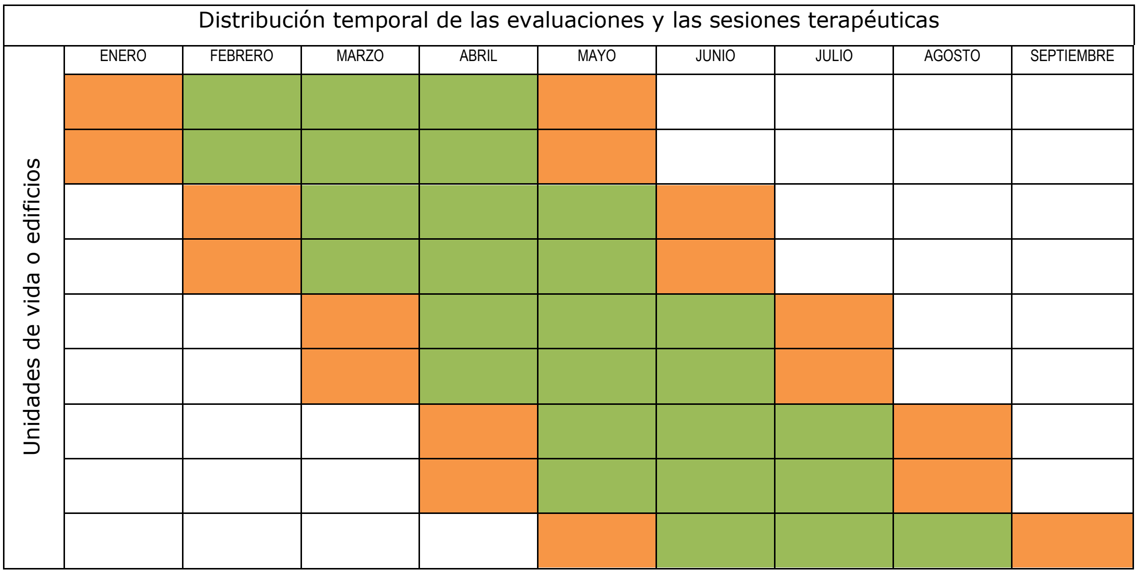

Tabla 4: Distribución temporal de las evaluaciones y las sesiones terapéuticas del estudio. Las sesiones terapéuticas del estudio, así como sus evaluaciones, no tuvieron lugar en un mismo periodo de tiempo, sino que se realizaron de manera escalonada. Así por ejemplo, en abril, se realizó la terapia en seis unidades (verde) y la evaluación en dos de ellas (naranja).

Plan de trabajo

Para llevar a cabo este proyecto se realizaron las siguientes tareas:

- **Reclutamiento de la muestra** (Duración: 14 meses)

  El reclutamiento de los participantes se realizó mediante llamada telefónica en la cual se citaba a una entrevista a los interesados. En dicha entrevista se facilitaba la información del estudio por escrito, se detallaban sus aspectos más importantes, se respondía cualquier duda y se obtenía el consentimiento informado por escrito de los representantes legales o los guardadores de hecho. Se habilitó un correo electrónico y un número de teléfono para solventar posibles dudas. Posteriormente se aplicaron los criterios de inclusión y exclusión.

- **Preparación de las sesiones** (Duración: 3 meses por fase)

  En esta etapa se diseñaron y prepararon los guiones de las sesiones de cada uno de los grupos, adaptados a la gravedad de los participantes.

- **Preparación de los cuadernos de recogida de datos** y **base de datos** (Duración: 0,5 meses)

Se prepararon los cuadernos de recogida de datos para la obtención de la información de manera estandarizada. Así mismo, se definió y creó una base de datos para la recogida y posterior explotación de los resultados.

- **Preparación de los robots** (Duración: 2-2,5 meses para cada fase)

En esta tarea se realizaron las labores de programación del robot NAO, pruebas y ajuste del mismo por parte del grupo de ingenieros de la URJC, siguiendo el diseño de las sesiones realizado. PARO no requiere programación.

- **Aleatorización** (Duración: 1 día)

Se realizó una distribución aleatoria de los participantes en los tres grupos terapéuticos mediante el uso de un dado de seis caras.

- **Evaluación** (Duración: 1 mes para cada evaluación y grupo)

Las evaluaciones fueron realizadas por investigadores ciegos para la situación experimental.

- **Sesión terapéutica** (Duración: 2 horas/semana durante 3 meses en cada grupo)

Los terapeutas ocupacionales realizaron las sesiones habituales de terapia establecidas, aunque durante dos horas a la semana éstas se reemplazaron por el uso de robots o perros en los grupos experimentales o la terapia habitual (siguiendo el guión previamente realizado).

- **Base de datos** (Duración: 1 mes por fase)

Una vez recogida la información mediante los cuadernos de recogida de datos, se cumplimentó la base de datos y se realizó un posterior control de calidad para subsanar los posibles errores cometidos.

- **Análisis y publicación de resultados** (Duración: 2-3 meses)

Finalmente se realizó el análisis de la información recogida y se procedió a la presentación de los resultados obtenidos en congresos y a su publicación.

- **Inclusión de nuevos participantes**

Durante el periodo de lavado del proyecto se reabrió el periodo de inclusión de nuevos participantes (ver tarea de reclutamiento).

Análisis estadístico

La estadística descriptiva de la muestra incluyó el cálculo de las medidas de tendencia central y de dispersión (media, desviación estándar, rango), así como los porcentajes.

En muestras pequeñas (n<50) como los grupos de nuestro estudio es imprescindible determinar si el comportamiento de las variables sigue una distribución normal, ya que muchos de los test estadísticos asumen normalidad en los datos para su correcta aplicación e interpretación. En primer lugar se realizó un diagrama de cajas para evaluar si la distribución de los valores de las variables en nuestra muestra era simétrica, mostrando una acusada asimetría en la mayor parte de ellas (ver figura 6).

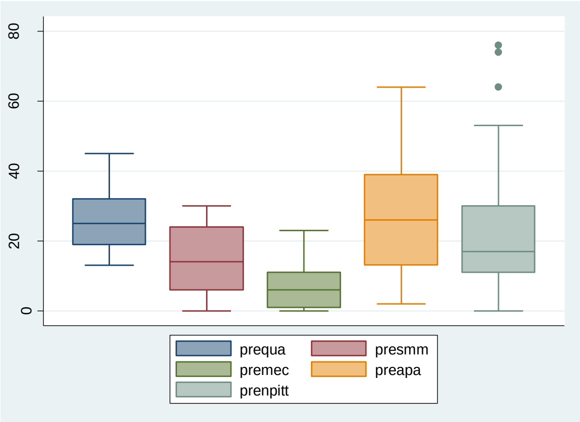

Figura 6: Diagrama de cajas. Se realizó un diagrama de cajas para cada una de las variables del estudio en cada una de sus fases para determinar si la distribución era simétrica o asimétrica, en la que se aprecia asimetría en las variables. En la imagen se aprecia la representación de las puntuaciones en la evaluación basal de las escalas: QUALID (prequa), MMSE (premec), NPI (prenpitt), sMMSE (presmm) y APADEM-NH (preapa).

Además, para confirmar los resultados de los diagramas de cajas se realizó la prueba de Shapiro-Wilk, apropiada para muestras pequeñas. Obtuvimos como resultado una $p<0,05$ en la práctica totalidad de las variables rechazando la hipótesis nula, por lo que asumimos que no seguían una distribución normal. Finalmente, se realizó un gráfico de simetría (ver figura 7) donde los puntos deben situarse sobre la diagonal para que sean indicativos de una distribución normal, hecho que no fue observado en la distribución de las variables de nuestro estudio.

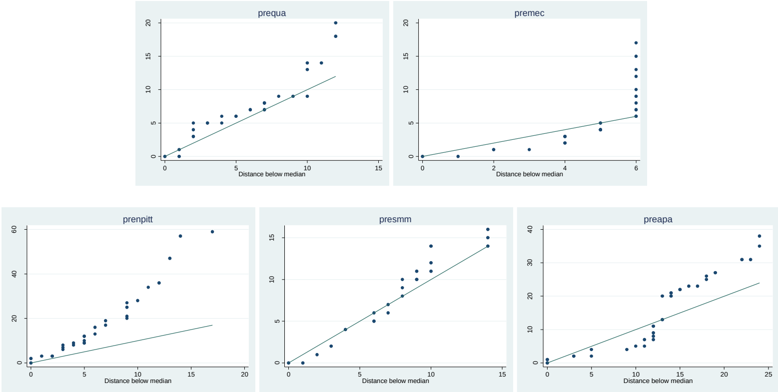

Figura 7: Gráficos de simetría. Ejemplo de gráficos de simetría en los que se aprecia que los puntos no se sitúan encima de la diagonal indicando que la distribución no sigue la normalidad. En la imagen se aprecia la representación de las puntuaciones en la evaluación basal de las escalas: QUALID (prequa), MMSE (premec), NPI (prenpitt), sMMSE (presmm) y APADEM-NH (preapa).

Debido a que la distribución de los datos no era normal y su nivel escalar es ordinal, se usó estadística no paramétrica para llevar a cabo las comparaciones entre grupos.

El test de Kruskal-Wallis se utilizó para comparar los resultados de la evaluación basal de los tres grupos para determinar si existían diferencias significativas en el valor de las variables entre grupos antes del inicio de las sesiones.

La prueba U de Mann-Whitney nos permitió determinar, analizando los grupos de terapia de dos en dos, si la diferencia observada en el valor de las variables entre dichos grupos era estadísticamente significativa.

Si bien se trataba de un estudio exploratorio, se realizó la corrección de Benjamini-Hochberg para comparaciones múltiples, calculando su valor medio como referencia (67):

P modificada media = p (m+1) / 2m

donde p = nivel de significación elegido (0,05 en este estudio)

m = número total de test

Siendo entonces: **p modificada media**=0,05 (20+1)/2*20=**0,02625**

El análisis estadístico fue realizado por un investigador ciego a la herramienta utilizada en las sesiones terapéuticas.

El análisis estadístico se realizó mediante software Stata (Stata ©. Stata Corp., College Station, Texas, USA versión: 14).

RESULTADOS

RESULTADOS

Reclutamiento y distribución de la muestra

Todas las personas con demencia de la residencia del CAFRS fueron informadas del proyecto. 117 pacientes y sus correspondientes familias facilitaron su consentimiento informado por escrito, si bien antes de la primera evaluación del estudio fallecieron 16 de ellos (ver figura 8).

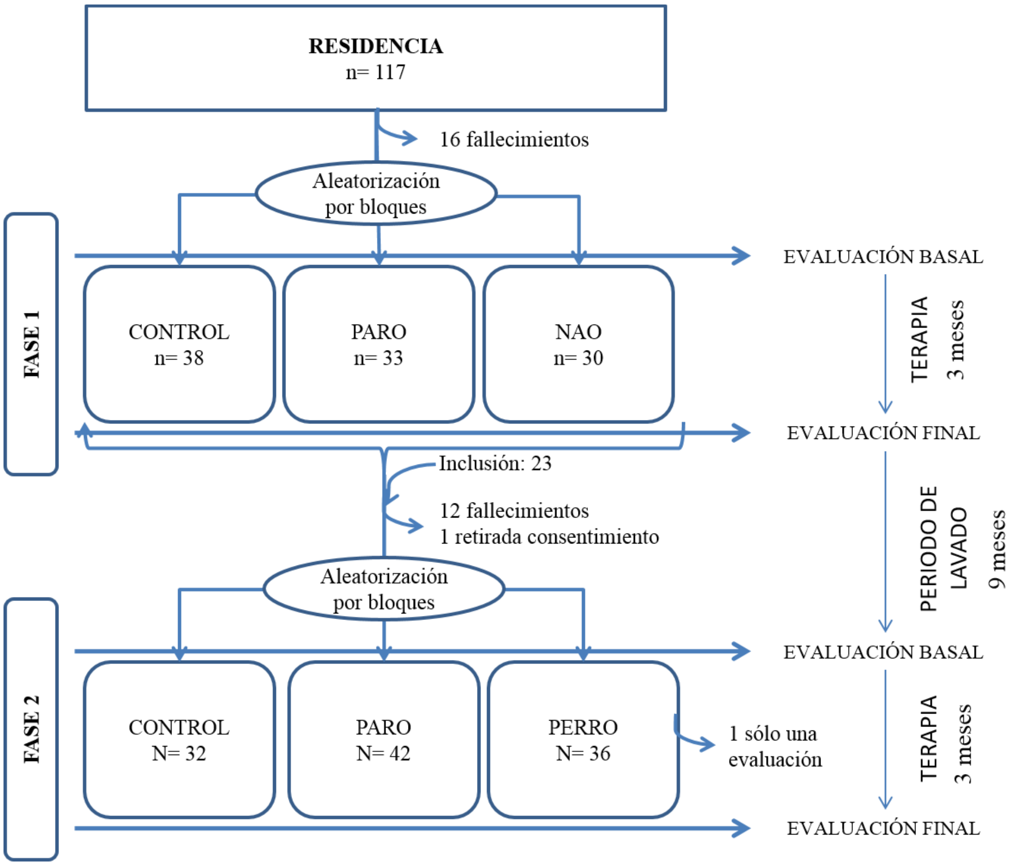

Figura 8: Diagrama de flujo del estudio con la distribución de la muestra. 117 participantes firmaron el consentimiento (sus responsables legales) y superaron los criterios de inclusión/exclusión, si bien 16 personas fallecieron antes de su aleatorización. En la Fase 1, 101 participantes se distribuyeron: 38 personas en el grupo CONTROL, 33 en el grupo PARO y 30 en el grupo NAO. En el periodo de lavado se incluyeron 23 personas, fallecieron 12 y 1 participante retiró el consentimiento. En la Fase 2, participaron 110 personas cuya distribución fue: 32 personas en el grupo CONTROL, 42 en el grupo PARO y 36 en el grupo PERRO. Las evaluaciones fueron antes y después de las sesiones del estudio. El periodo de terapia fue de 3 meses y el de lavado fue de 9 meses. Los participantes fueron aleatorizados en dos ocasiones antes de las evaluaciones basales.

Durante el periodo de lavado (de 9 meses de duración), 23 participantes cumplimentaron su consentimiento, 12 personas fallecieron y una persona retiró el consentimiento. En la segunda fase, una persona no completó las evaluaciones del estudio por estar de vacaciones fuera del CAFRS (figura 8).

Todos los participantes cumplieron los criterios de inclusión y ninguno de exclusión (no hubo casos de alergia ni miedo a las herramientas).

Características demográficas, tipo de demencia y gravedad del deterioro cognitivo

En la **primera fase** (ver tabla 5):

> Participaron 101 personas con demencia moderada-grave. La edad media de los voluntarios fue de 84,68 años (rango: 58-100 años) y el 88 % fueron mujeres. Los valores de la escala GDS fueron de: GDS 4: 2%; GDS 5: 16,8%; GDS 6: 44,6% y GDS 7: 36,6%.
>
> El diagnóstico clínico de los participantes fue: 84,2% Enfermedad de Alzheimer, 10,9% Demencia Mixta (Enfermedad de Alzheimer y daño vascular), 3% Demencia en la Enfermedad de Parkinson, 1% Demencia con Cuerpos de Lewy y 1% Demencia Frontotemporal.

		FASE 1 (n=101)		FASE 2 (n=110)	
EDAD MEDIA (RANGO)		84,68 (58-100)		84,7 (59-101)	
		TOTAL	%	TOTAL	%
SEXO FEMENINO		89	88	99	90
TIPO DE DEMENCIA	ENFERMEDAD DE ALZHEIMER	85	84,2	97	88,2
	DEMENCIA MIXTA	11	10,9	8	7,3
	DEMENCIA EN ENF. PARKINSON	3	3	4	3,6
	DEMENCIA CON CUERPOS DE LEWY	1	1	2	1,8
	DEMENCIA FRONTOTEMPORAL	1	1	1	0,9
ESCALA DE DETERIORO GLOBAL (GDS)	4 (LEVE)	2	2	0	0
	5 (MODERADO)	17	16,8	24	21,8
	6 (MODERADO-GRAVE)	45	44,6	34	30,9
	7 (GRAVE)	37	36,6	52	47,3

Tabla 5: Características de los participantes. Tabla resumen con la edad, el sexo, el tipo de demencia y el estado de deterioro global de los participantes en ambas fases del estudio.

La distribución de los participantes entre los diferentes grupos terapéuticos fue: 38 personas en el grupo CONTROL, 33 en el grupo PARO y 30 en el grupo NAO.

En la **segunda fase** (ver tabla 5):

Participaron 110 personas con demencia moderada-grave. La edad media de los voluntarios fue de 84,7 años (rango: 59-101 años), siendo el 90% mujeres. Los valores de la escala GDS fueron de: GDS 5: 21,8%, GDS 6: 30,9% y GDS 7: 47,3%.

Su diagnóstico de demencia seguía los criterios de: 88,2% Enfermedad de Alzheimer, 7,3% Demencia mixta (Enfermedad de Alzheimer y daño vascular), 3,6% Demencia en la Enfermedad de Parkinson, 1,8% Demencia con cuerpos de Lewy y 0,9% Demencia Frontotemporal.

La distribución de los mismos en los diferentes grupos terapéuticos fue:
32 personas en el grupo CONTROL, 42 en el grupo PARO y 36 en el grupo PERRO.

Fase 1

La evaluación basal no mostró diferencias significativas entre grupos.

Todos los grupos mostraron un incremento en las puntuaciones del GDS indicando un empeoramiento a nivel funcional en el seguimiento.

Las puntuaciones en las escalas QUALID, sMMSE y NPI (puntuación total) no mostraron cambios estadísticamente significativos entre grupos en el seguimiento.

En cambio, se hallaron diferencias estadísticamente significativas en las puntuaciones de (ver gráfico 1 y tabla 6):

- **MMSE**: un descenso significativo en el grupo NAO respecto al grupo CONTROL,

- APADEM-NH. En esta escala se apreció un (ver gráfico 2):
  - descenso en la puntuación total en el grupo PARO (p=0,049) y NAO (p=0,03) y
  - descenso en la puntuación de inercia cognitiva del grupo NAO (p=0,034), respecto al grupo CONTROL.

- NPI. Varios ítems de la escala NPI presentaron diferencias (ver gráfico 3):
  - **delirios**: un aumento significativo en el grupo NAO respecto al grupo CONTROL (p=0,011),
  - apatía: un descenso significativo en el grupo NAO respecto al grupo CONTROL (p=0,047), e
  - irritabilidad/labilidad: un aumento significativo en el grupo PARO respecto al grupo CONTROL (p=0,033),

No obstante, tras la corrección de Benjamini-Hochberg sólo restaron estadísticamente significativos los cambios descritos en las variables MMSE y el ítem delirios de la escala NPI (marcados en negrita en los párrafos anteriores).

No se apreciaron diferencias estadísticamente significativas entre los grupos NAO y PARO.

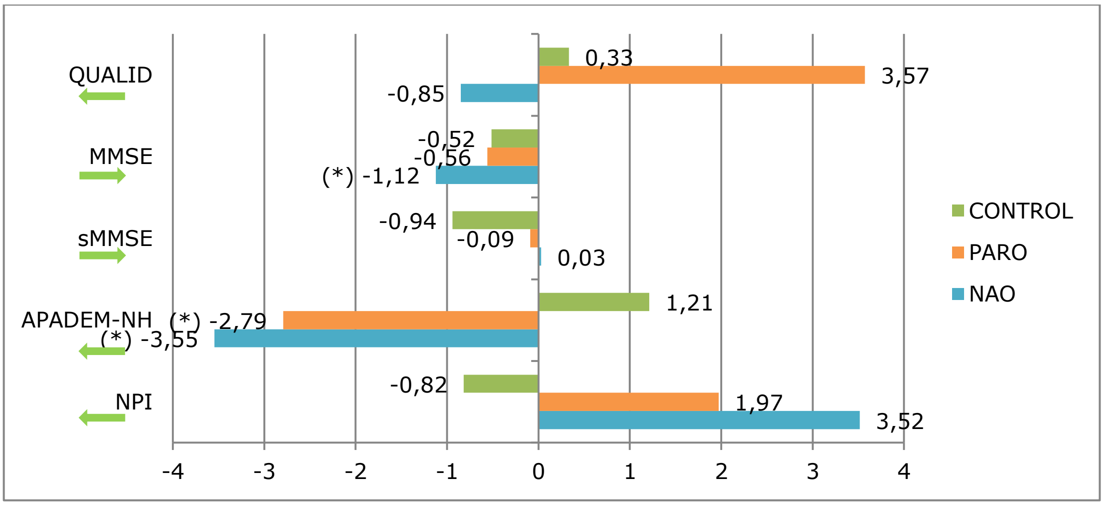

Gráfico 1: Resultados de las variables por grupo terapéutico en la Fase 1. Se expresa el resultado mediante la media del cambio entre la evaluación inicial y final. La flecha verde señala el sentido que indica mejoría sintomática. El asterisco indica p<0,05. CONTROL: grupo CONTROL; PARO: grupo PARO; NAO: grupo NAO.

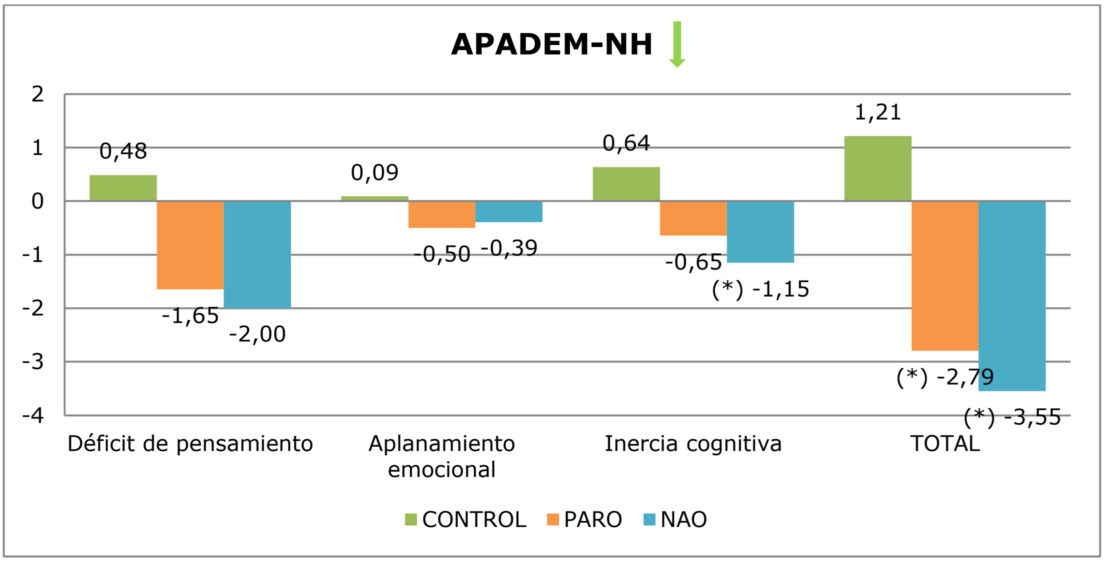

Gráfico 2: Resultados de la escala APADEM-NH, total y de sus tres ítems, por grupo terapéutico en la Fase 1. Se expresa el resultado mediante la media del cambio entre la evaluación inicial y final. La flecha verde señala el sentido que indica mejoría sintomática. El asterisco indica p<0,05. CONTROL: grupo CONTROL; PARO: grupo PARO; NAO: grupo NAO.

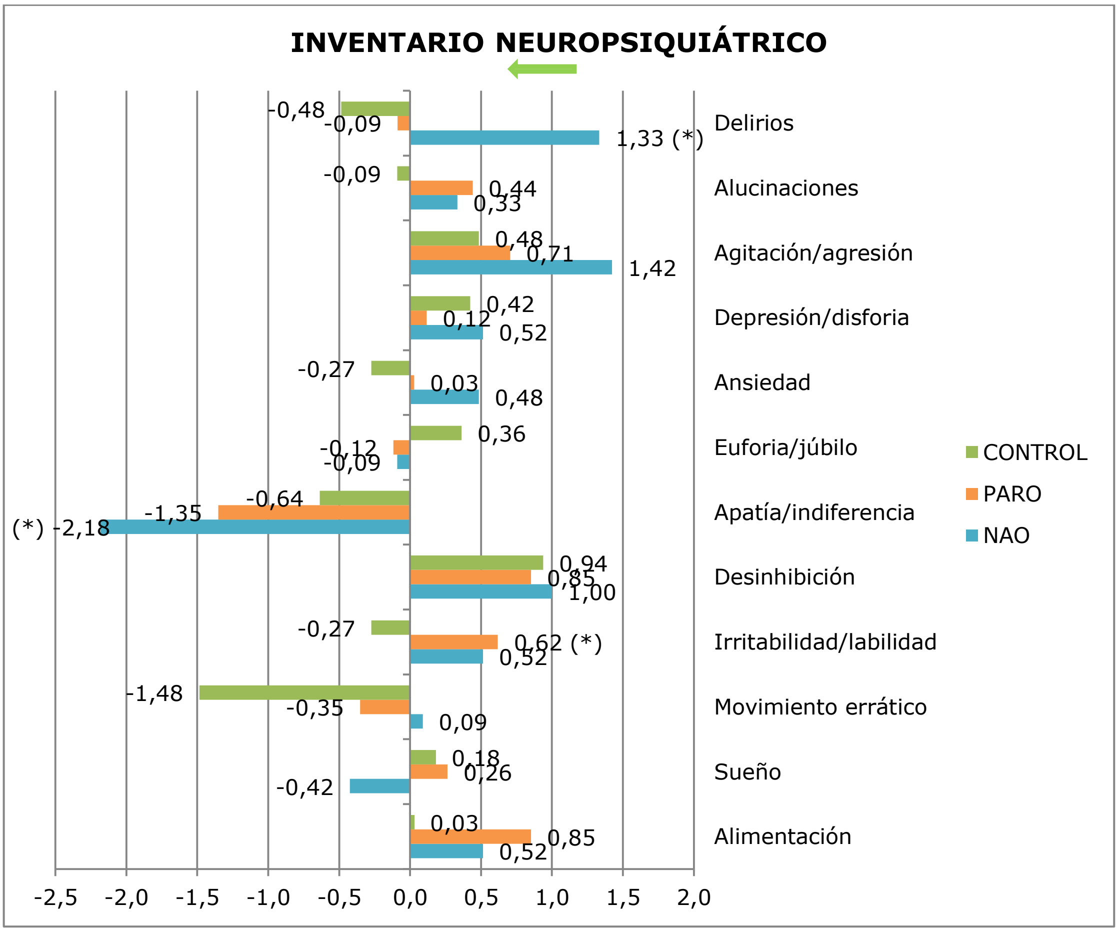

Gráfico 3: Resultados de la escala NPI, total y sus doce ítems, por grupo terapéutico en la Fase 1. Se expresa el resultado mediante la media del cambio entre la evaluación inicial y final. La flecha verde señala el sentido que indica mejoría sintomática. El asterisco indica p<0,05. CONTROL: grupo CONTROL; PARO: grupo PARO; NAO: grupo NAO.

VARIABLES (FASE 1: 2012)	CONTROL						PARO						P C-P	NAO						P C-N	P P-N
	BASAL	SD	FINAL	SD	CAMBIO	SD	BASAL	SD	FINAL	SD	CAMBIO	SD		BASAL	SD	FINAL	SD	CAMBIO	SD		
QUALID	24,52	8,24	24,85	6,23	0,33	5,22	23,74	6,63	27,31	7,71	3,57	6,41	0,174	25,94	9,48	25,09	6,31	-0,85	5,97	0,576	0,062
MMSE	3,64	5,42	3,12	4,72	-0,52	1,77	3,20	4,95	2,74	4,72	-0,56	1,86	0,282	3,55	5,18	2,42	4,49	-1,12	2,72	**0,022**	0,145
SMMSE	8,67	10,14	7,73	9,56	-0,94	2,62	7,97	8,84	8,12	9,68	-0,09	3,40	0,239	7,76	8,65	7,79	9,00	0,03	4,59	0,702	0,586
APADEM-NH	43,21	21,80	44,42	23,59	1,21	10,87	48,40	19,12	44,74	22,29	-2,79	9,27	0,049	45,06	20,69	41,52	22,59	-3,55	12,35	0,030	0,564
déficit pensamiento	21,58	10,27	22,06	11,42	0,48	5,48	24,66	8,75	22,59	10,50	-1,65	5,44	0,084	22,39	9,98	20,39	10,13	-2,00	6,19	0,055	0,806
aplanamiento emocional	10,91	6,40	11,00	6,74	0,09	3,75	11,77	5,93	11,00	6,80	-0,50	3,45	0,420	10,64	6,02	10,24	6,98	-0,39	4,93	0,491	0,875
inercia cognitiva	10,73	5,89	11,36	6,32	0,64	4,32	11,97	5,27	11,15	5,79	-0,65	3,13	0,251	12,03	5,48	10,88	6,30	-1,15	3,56	0,034	0,313
NPI	27,36	14,01	26,55	16,05	-0,82	13,89	22,17	12,96	24,44	17,10	1,97	12,44	0,246	27,94	15,03	31,45	21,55	3,52	16,07	0,238	0,782
delirios	0,91	1,99	0,42	1,54	-0,48	1,54	0,66	1,98	0,59	2,23	-0,09	3,14	0,455	0,79	1,82	2,12	3,90	1,33	3,31	**0,011**	0,063
alucinaciones	0,67	1,41	0,58	1,60	-0,09	1,16	0,23	0,77	0,68	2,21	0,44	2,36	0,540	1,03	2,13	1,36	2,95	0,33	2,80	0,490	0,843
agitación	2,82	3,72	3,30	4,00	0,48	2,67	2,46	3,70	3,24	4,06	0,71	3,47	0,531	2,94	2,93	4,36	4,05	1,42	3,21	0,083	0,317
depresión	0,94	1,66	1,36	2,51	0,42	2,36	0,89	2,01	1,03	2,22	0,12	1,81	0,838	1,73	2,82	2,24	3,50	0,52	1,84	0,783	0,571
ansiedad	2,27	3,14	2,00	2,93	-0,27	3,81	1,66	2,44	1,74	2,37	0,03	2,80	0,475	2,21	3,16	2,70	3,33	0,48	3,62	0,431	0,935
euforia	0,12	0,70	0,48	1,66	0,36	1,83	0,11	0,68	0,00	0,00	-0,12	0,69	0,177	0,09	0,52	0,00	0,00	-0,09	0,52	0,184	1,000
apatía	8,73	2,54	8,09	3,43	-0,64	3,22	9,26	2,28	7,82	3,35	-1,35	3,18	0,292	8,85	2,55	6,67	3,96	-2,18	3,37	0,047	0,275
desinhibición	0,30	1,02	1,24	2,29	0,94	2,61	0,11	0,68	0,97	2,52	0,85	2,26	0,755	0,15	0,71	1,15	2,86	1,00	3,01	0,670	0,842
irritabilidad	2,58	2,97	2,30	3,02	-0,27	2,89	1,89	2,99	2,56	3,78	0,62	2,56	0,033	3,21	3,66	3,73	3,67	0,52	3,75	0,085	0,728
movimiento errático	3,76	4,21	2,27	3,46	-1,48	4,53	2,20	3,31	1,91	2,87	-0,35	4,19	0,185	2,88	3,37	2,97	3,81	0,09	3,78	0,075	0,647
sueño	1,64	3,27	1,82	3,34	0,18	3,13	1,54	2,76	1,85	3,41	0,26	2,68	0,636	2,03	3,05	1,61	3,37	-0,42	2,95	0,269	0,105
alimentación	2,64	3,72	2,67	3,51	0,03	4,92	1,17	2,66	2,06	3,43	0,85	3,60	0,640	2,03	2,83	2,55	3,85	0,52	4,54	0,832	0,461

Tabla 6: Resultados de las variables del estudio (totales e ítems) para los tres grupos terapéuticos en la Fase 1. Se expresan los resultados con la media de las puntuaciones en las evaluaciones basal (BASALES) y final (FINAL), así como la media del cambio (CAMBIO) entre las evaluaciones, junto a su desviación estándar (SD). Los valores de p<0,02625 están en negrita.

Fase 2

La evaluación basal no mostró diferencias significativas entre los diferentes grupos, salvo en el ítem de *irritabilidad* de la escala NPI (CONTROL: 3,78 ± 3,3; PARO: 2,14 ± 3,05; PERRO: 2,13 ± 3,28; p=0,0215).

Además, todos los grupos mostraron un incremento en las puntuaciones del GDS en el seguimiento, indicando un empeoramiento a nivel funcional.

No se observaron diferencias estadísticamente significativas en las puntuaciones de las escalas MMSE, sMMSE, APADEM-NH y NPI total entre grupos durante el seguimiento.

En cambio, se hallaron diferencias estadísticamente significativas en (ver gráfico 4 y tabla 7):

- la escala de QUALID: un incremento en el grupo PARO respecto al grupo CONTROL, y en

- la escala NPI. Varios ítems de la escala NPI mostraron diferencias (ver gráfico 6):
    - **alucinaciones**: un aumento en los grupos PARO (p=0,020) y PERRO (p=0,004), respecto al grupo CONTROL
    - **desinhibición**: un aumento en el grupo PARO respecto al grupo PERRO (p=0,026),y
    - **irritabilidad**: un aumento en el grupo PARO (p=0,003) y PERRO (p=0,024), respecto al grupo CONTROL
    - trastornos del comportamiento nocturno: un descenso en el grupo PARO respecto al grupo PERRO (p=0,028).

Posteriormente, tras aplicar de nuevo la corrección de Benjamini-Hochberg los cambios observados en la escala QUALID y en el ítem de trastornos del comportamiento nocturno de la escala NPI dejaron de ser estadísticamente significativos. Sólo restaron estadísticamente significativas las variables marcadas en negrita.

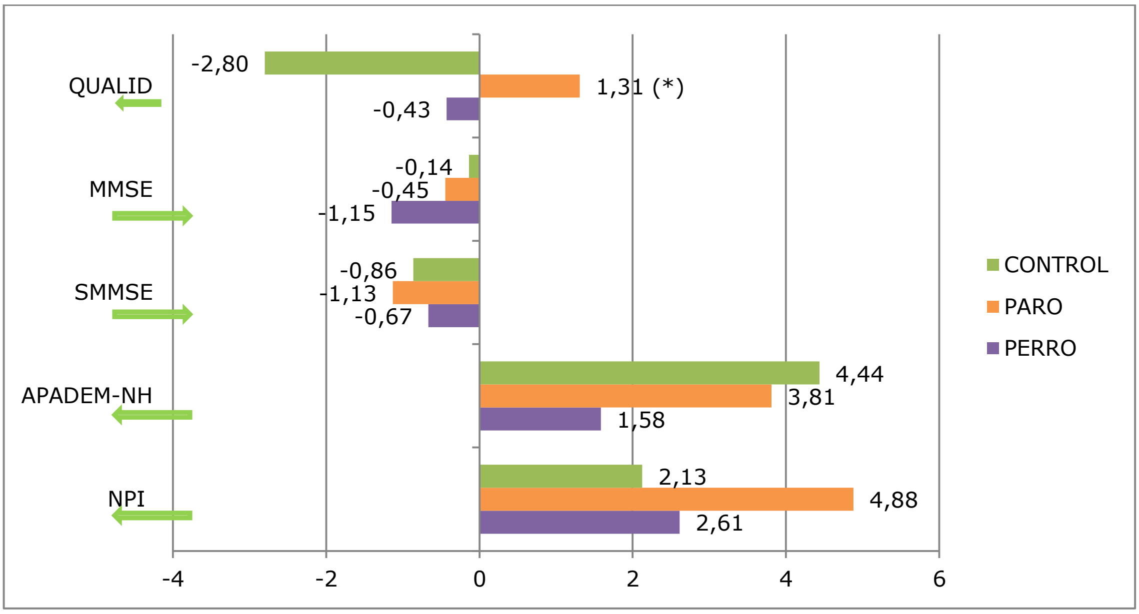

Gráfico 4: Resultados de las variables por grupo terapéutico en la Fase 2. Se expresa el resultado mediante la media del cambio entre la evaluación inicial y final. La flecha verde señala el sentido que indica mejoría sintomática. El asterisco indica p<0,05. CONTROL: grupo CONTROL; PARO: grupo PARO; NAO: grupo NAO.

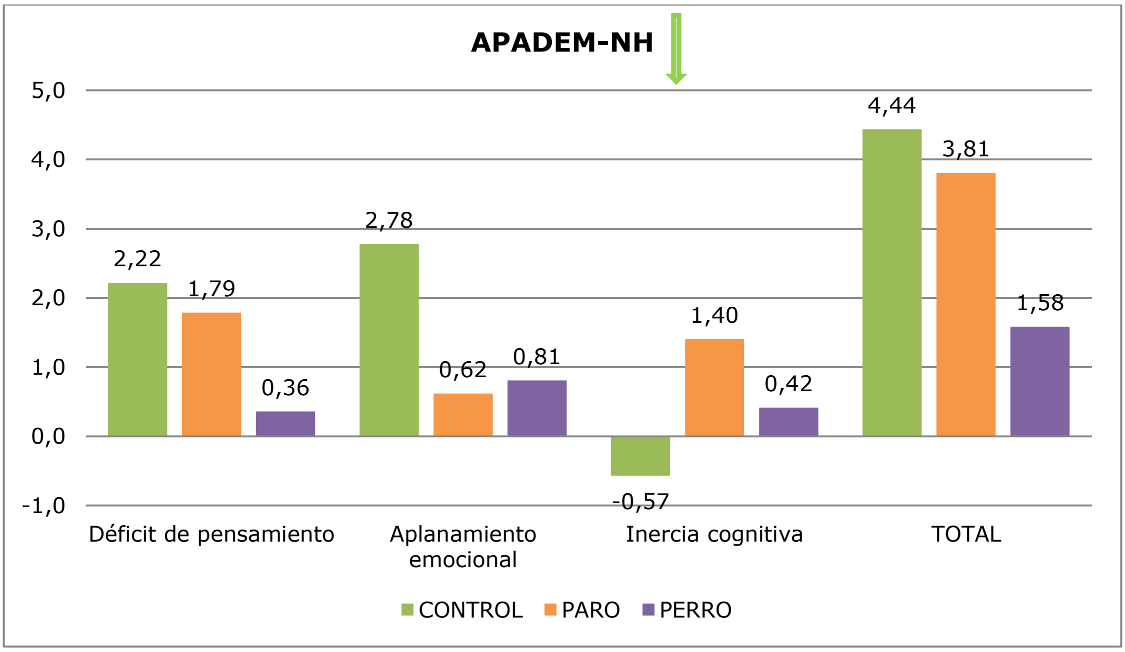

Gráfico 5: Resultados de la escala APADEM-NH, total y de sus tres ítems, por grupo terapéutico en la Fase 2. Se expresa el resultado mediante la media del cambio entre la evaluación inicial y final. La flecha verde señala el sentido que indica mejoría sintomática. El asterisco indica p<0,05. CONTROL: grupo CONTROL; PARO: grupo PARO; NAO: grupo NAO.

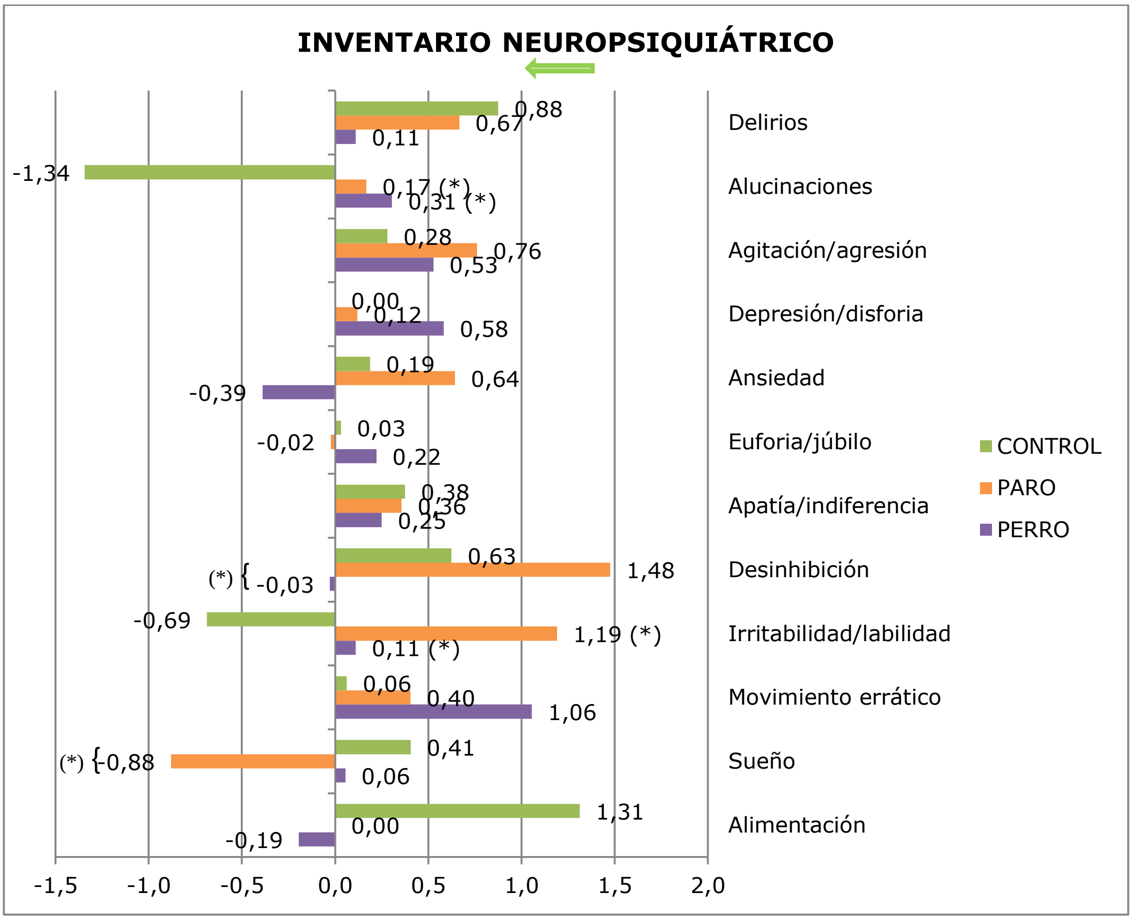

Gráfico 6: Resultados de la escala NPI, total y sus doce ítems, por grupo terapéutico en la Fase 2. Se expresa el resultado mediante la media del cambio entre la evaluación inicial y final. La flecha verde señala el sentido que indica mejoría sintomática. El asterisco indica p<0,05. CONTROL: grupo CONTROL; PARO: grupo PARO; NAO: grupo NAO.

VARIABLES (FASE 2: 2013)	CONTROL						PARO						P C-P	PERRO						P C-D	P P-D
	BASAL	SD	FINAL	SD	CAMBIO	SD	BASAL	SD	FINAL	SD	CAMBIO	SD		BASAL	SD	FINAL	SD	CAMBIO	SD		
QUALID	27,70	7,82	24,72	6,68	-2,80	5,79	25,44	7,56	26,75	8,16	1,31	7,52	0,044	24,91	7,39	24,33	6,68	-0,43	7,42	0,101	0,547
MMSE	2,69	4,65	2,48	4,96	-0,14	3,78	4,05	6,35	3,92	6,77	-0,45	4,27	0,846	3,84	5,79	2,80	5,20	-1,15	3,21	0,496	0,574
SMMSE	6,78	8,65	5,72	8,81	-0,86	4,60	8,60	10,79	8,10	10,00	-1,13	5,88	0,968	8,48	10,32	7,63	10,66	-0,67	4,64	0,937	0,866
APADEM-NH	41,13	22,04	45,56	25,66	4,44	16,84	40,83	22,70	44,64	22,31	3,81	12,96	0,715	42,17	24,28	43,75	22,63	1,58	11,07	0,376	0,659
déficit pensamiento	20,69	10,66	22,91	12,70	2,22	8,33	20,69	10,97	22,48	10,95	1,79	6,92	0,607	21,78	11,46	22,14	10,92	0,36	5,70	0,365	0,736
aplanamiento emocional	8,78	6,61	11,56	7,72	2,78	5,46	9,67	6,60	10,29	6,28	0,62	4,24	0,056	9,61	7,51	10,42	6,72	0,81	4,27	0,132	0,499
inercia cognitiva	11,66	5,79	11,09	6,57	-0,57	5,22	10,48	6,14	11,88	5,93	1,40	3,99	0,239	10,78	6,11	11,19	5,76	0,42	3,79	0,848	0,314
NPI	26,53	20,33	28,66	19,08	2,13	22,26	24,40	16,15	29,29	19,60	4,88	12,76	0,294	19,72	15,15	22,33	14,67	2,61	18,06	0,649	0,364
delirios	0,28	1,11	1,16	3,32	0,88	3,52	0,64	1,71	1,31	3,03	0,67	2,79	0,695	0,44	1,68	0,56	2,37	0,11	2,99	0,353	0,173
alucinaciones	1,81	3,18	0,47	1,54	-1,34	3,16	0,93	2,32	1,10	1,92	0,17	1,75	**0,020**	0,17	0,74	0,47	1,21	0,31	1,31	**0,004**	0,625
agitación	2,72	3,60	3,00	4,55	0,28	4,20	2,88	3,86	3,64	4,84	0,76	3,38	0,204	1,81	3,02	2,33	3,60	0,53	3,88	0,429	0,587
depresión	1,09	2,20	1,09	2,29	0,00	2,17	1,05	2,39	1,17	2,29	0,12	2,58	0,378	0,50	1,52	1,08	2,57	0,58	1,96	0,141	0,568
ansiedad	2,34	3,22	2,53	3,63	0,19	3,58	1,74	2,82	2,38	3,36	0,64	3,38	0,530	1,69	3,03	1,31	2,58	-0,39	3,80	0,783	0,301
euforia	0,22	0,79	0,25	0,98	0,03	0,40	0,02	0,15	0,00	0,00	-0,02	0,15	0,621	0,00	0,00	0,22	0,93	0,22	0,93	0,335	0,076
apatía	7,56	3,89	7,94	4,05	0,38	3,46	7,60	3,68	7,95	3,84	0,36	2,98	0,977	7,92	3,87	8,17	3,21	0,25	3,55	0,984	0,935
desinhibición	0,91	2,68	1,53	3,36	0,63	4,21	0,62	1,41	2,10	3,88	1,48	3,42	0,172	0,92	2,52	0,89	2,61	-0,03	2,82	0,599	**0,026**
irritabilidad	3,78	3,31	3,09	4,17	-0,69	3,51	2,14	3,06	3,33	4,23	1,19	3,71	**0,003**	2,14	3,29	2,25	2,93	0,11	3,37	**0,024**	0,873
movimiento errático	2,56	3,29	2,63	4,14	0,06	4,23	1,98	3,43	2,38	3,75	0,40	4,47	0,724	1,28	2,44	2,33	3,08	1,06	3,40	0,161	0,263
sueño	1,16	2,26	1,56	3,19	0,41	3,69	2,43	3,51	1,55	2,78	-0,88	2,27	0,078	1,11	2,69	1,17	2,36	0,06	2,78	0,771	0,028
alimentación	2,09	3,77	3,41	4,01	1,31	4,45	2,38	3,88	2,38	3,39	0,00	4,88	0,267	1,75	3,29	1,56	3,36	-0,19	4,32	0,135	0,684

Tabla 7: Resultados de las variables del estudio (totales e ítems) para los tres grupos terapéuticos en la Fase 1. Se expresan los resultados con la media de las puntuaciones en las evaluaciones basal (BASALES) y final (FINAL), así como la media del cambio (CAMBIO) entre las evaluaciones, junto a su desviación estándar (SD). Los valores de p<0,02625 están en negrita.

Cambios farmacológicos

El tratamiento farmacológico de acción psicoactiva fue controlado, dado que el médico especialista en geriatría habitual fue libre de modificar la prescripción a lo largo del estudio. Dicha medicación podía modificar algunas de las variables del estudio, por ello se analizaron sus variaciones. Se recogió toda la medicación psicoactiva prescrita en la evaluación inicial y en la evaluación final.

	2012						2013					
	CONTROL		PARO		NAO		CONTROL		PARO		PERRO	
	n	%	n	%	n	%	n	%	n	%	n	%
AUMENTO	2	5,3	1	3	5	16,7	0	0	4	14,2	1	2,8
DESCENSO	7	18,4	2	6,1	3	10	1	3,1	7	19	3	8,3
SIN CAMBIOS	29	76,3	30	90,9	22	73,3	31	96,8	31	66,7	32	88,9
TOTAL	38	100	33	100	30	100	32	100	42	100	36	100

Tabla 8: Cambios en la medicación psicoactiva. Número de personas, y porcentaje, cuya medicación psicoactiva se mantuvo sin cambios (SIN CAMBIOS), aumentó (AUMENTO) o disminuyó (DESCENSO) a lo largo de la fase 1 y 2 del estudio por grupo terapéutico.

La mayoría de los participantes no cambiaron de tratamiento durante el estudio (ver tabla 8).

En la fase 1, se produjo un descenso de la medicación en el grupo CONTROL (18,4%: 7 personas, respecto al 5,3% que aumentó) y un aumento en el grupo NAO (16,7%: 5 personas, respecto al 10% que descendió).

En la fase 2, disminuyó la prescripción de medicación psicoactiva en el grupo PARO (19%: 7 personas, respecto al 14,2% que aumentó) y PERRO (8,3%: 3 personas, respecto al 2,8% que aumentó).

DISCUSIÓN

DISCUSIÓN

La aplicación de animales y de robots sociales en la terapia de las personas con demencia ya había sido descrita en múltiples ocasiones en la literatura.

No se halló en la literatura una comparación entre robots sociales, un robot mascota y un robot humanoide, como potenciales herramientas de terapia para personas con demencia con anterioridad a este estudio. Además, fue la primera ocasión que se utilizó al robot humanoide NAO para dicho propósito.

También fue la primera ocasión en la que se realizaba una comparación entre el robot social PARO con un perro de terapia en las sesiones de terapia ocupacional de personas con demencia. En 2013, Robinson et al (45) publicaron el primer ensayo controlado aleatorizado con PARO e indicaban que sus efectos no se habían comparado con los de un animal con anterioridad. Pero en su estudio realizaban un ensayo clínico con un grupo CONTROL y un grupo PARO, de 20 personas cada uno (sólo la mitad de ellos con deterioro cognitivo). El perro usado en dicho estudio fue el del coordinador de actividades y acudió sólo a algunas de las sesiones del estudio de manera no estructurada y parcial, realizando entonces la comparación PARO-ANIMAL (si bien no aparecía en el diagrama de flujo del estudio). El grupo PARO realizó grupos de discusión mientras interactúan con PARO mientras que el grupo CONTROL realizó excursiones en autobús, manualidades, vio películas de cine o jugó al bingo. El grupo PARO recibió en ocasiones la visita del perro, pero no queda claro si el grupo CONTROL también. Mientras publicaban sus resultados, se estaba llevando a cabo la fase 2 del estudio comparando los grupos CONTROL, PARO y PERRO.

Las herramientas del estudio fueron el único cambio introducido en la intervención. Se intentó en la medida de lo posible evitar cualquier otro cambio en la organización de la residencia (personal, horarios, rutinas…) para limitar los posibles factores de confusión.

Las variables utilizadas en este estudio fueron escalas validadas internacionalmente que han demostrado ser sensibles y específicas para medir los síntomas diana. Además, todas las evaluaciones fueron realizadas por profesionales entrenados en el uso de dichas escalas ciegos a la herramienta utilizada. Las escalas utilizadas requieren observación y/o exploración de las personas con demencia o bien entrevista al cuidador profesional. En este estudio no se pudieron incluir cuestionarios a las personas con demencia porque el grado de evolución de su enfermedad (GDS 6 y 7) impedía su correcta cumplimentación. Los cambios observados tras la introducción de estas nuevas herramientas han afectado a todas las variables investigadas.

En la discusión se indican algunos de los resultados de éste u otros estudios. Se expresan mediante la media del cambio, la desviación estándar y su valor de p usándose las iniciales C para CONTROL, P para PARO, N para NAO y D para PERRO.

Aceptabilidad de los robots sociales y los animales

Las nuevas herramientas fueron bien aceptadas por los participantes, ya tuvieran demencia leve, moderada o grave. Las únicas personas que pusieron objeciones al principio fueron:

- algunos usuarios con demencia moderada prefirieron no tocar el robot mascota al principio de la sesión, si bien no les molestó su presencia. Sin embargo, a lo largo de las sesiones, se pudo constatar que, si bien no tenían un recuerdo de la herramienta, fueron acercándose cada vez más a ella y en algunas ocasiones fue difícil separarles de PARO.
- algunos usuarios con demencia leve-moderada no deseaban participar en las sesiones porque creían que PARO no era adecuada para adultos. Pero a lo largo de la primera sesión, fueron cambiando de parecer y empezaron a interactuar con ella, agradeciendo finalmente su uso.

Los terapeutas se adaptaron al uso de las herramientas rápidamente, si bien alguno al principio expresó su reticencia (a los robots) o cierto miedo (a los perros), tras su entrenamiento y habituación todas las dudas o temores fueron superados.

Los familiares en general se mostraron complacidos por el uso de los robots y de los animales en las sesiones de terapia e incluso llegaron a contactar con los investigadores para agradecer su uso. Fue sorprendente el hecho de que lo que más apreciaron fue el orgullo con el que los más jóvenes de la casa miraban a sus abuelos por estar participando en sesiones de terapia con robots o animales.

Adaptación al modelo de terapia ocupacional

En este proyecto no se modificó el modelo de terapia habitual del centro. Se introdujeron las herramientas como un elemento más de la terapia.

Los terapeutas ocupacionales y un neuropsicólogo se encargaron de diseñar y adaptar las sesiones terapéuticas de las personas con demencia al uso de las nuevas herramientas. Los terapeutas recibieron unas mínimas instrucciones para la implantación y los posibles usos de los robots y los animales, dado que era la primera vez que los utilizaban, pero estos profesionales fueron los que crearon, de manera libre, la aplicación de las herramientas para obtener su propósito.

Es importante remarcar que el objetivo fue comparar el efecto de las herramientas, así que éstas se usaron para un mismo fin y de una manera similar en los tres grupos terapéuticos, dentro de lo posible.

Es de destacar que las sesiones se diseñaron para distintos grados de deterioro cognitivo y se fueron adaptando, de manera similar en todos los grupos, a medida que los usuarios iban empeorando.

Deterioro global y estado cognitivo

El deterioro global y el estado cognitivo, medidos con las escalas GDS de Reisberg, MMSE y sMMSE, empeoraron levemente en el seguimiento. Dicho empeoramiento está descrito en la demencia neurodegenerativa (el rango de la media del cambio de los grupos terapéuticos del MMSE osciló entre -1,15 y -0,14 y, entre -1,13 y 0,03 en la escala sMMSE).

Las escalas cognitivas MMSE y sMMSE mostraron un importante efecto suelo, siendo la puntuación basal inferior a 5 en un 75,25 % y un 50,5 % de los participantes de la fase 1, respectivamente; estos porcentajes fueron del 68,18% y 53,63% respectivamente en la fase 2. Durante la realización de este estudio, se consideró la necesidad de aplicar escalas breves con menor efecto suelo en la evaluación cognitiva de esta muestra. Por este motivo, se llevó a cabo en el CAFRS el análisis factorial de la escala SIB para obtener una versión abreviada de la misma (68), así como una nueva escala cognitiva y funcional para personas con demencia avanzada (69). Si bien el resultado de esta iniciativa fue posterior a la finalización de este estudio, por lo que no se pudo beneficiar del uso de dichas escalas.

En la primera fase del estudio se apreció un descenso en las puntuaciones de la escala MMSE en todos los grupos (CONTROL:-0,52 ± 1,77; PARO -0,56 ± 1,86; NAO -1,12 ± 2,72) siendo la diferencia del cambio entre el grupo CONTROL y el grupo NAO estadísticamente significativa (p=0,022) (ver tabla 6). Si bien las puntuaciones del sMMSE permanecieron prácticamente estables en ambos grupos robot, mientras descendían en el grupo CONTROL (CONTROL: -0,94 ± 2,62; PARO -0,09 ± 3,40; NAO 0,03 ± 4,59; p C-N=0,702). A pesar de que MMSE y sMMSE son escalas de medida para el estado cognitivo, el sMMSE es más apropiado para las personas con demencia moderada-grave. En la segunda fase del estudio no se hallaron diferencias estadísticamente significativas.

En la literatura se encuentran estudios sobre el efecto de la terapia con animales en la cognición de las personas con demencia (38,70–74), si bien los resultados no son significativos. Aunque una revisión halló que tenían un efecto en la comunicación y en la habilidad de copia, pero no en la evaluación cognitiva (26). Únicamente el estudio de Moretti et al (72) observó una mejoría significativa en la orientación espacial, la concentración y el pensamiento abstracto (p=0,05).

También en el caso de los robots encontramos varios artículos que describen el uso de robots sociales como herramientas para monitorizar y estimular actividades cognitivas a personas mayores y/o personas con demencia para mejorar la realización de las tareas y reducir la frustración del usuario (75–77). En 2008, utilizaron un electroencefalograma para determinar la actividad neuronal cortical de las personas con demencia después del uso de PARO y detectaron una ligera mejoría (78).

El aumento en la actividad neuronal cortical y la mayor motivación para realizar y completar las tareas cognitivas podría conllevar una mejoría en los resultados de los test cognitivos. Pero en este estudio no se ha observado mejoría en el estado cognitivo de los participantes, al contrario, los participantes de los tres grupos han empeorado levemente.

Cambios en el comportamiento

Doce síntomas neuropsiquiátricos se analizaron mediante las escalas NPI y APADEM-NH.

Apatía

La apatía es el síntoma más destacado en la demencia. En la primera fase, se observó una mejoría en las puntuaciones totales de la escala APADEM-NH de las personas de ambos grupos robot, así como en las puntuaciones en el ítem de apatía de la escala NPI y en el ítem de inercia cognitiva de la escala APADEM-NH en los participantes del grupo NAO. Si bien tras aplicar la corrección de Bonferroni-Hochberg dichas diferencias entre grupos no fueron estadísticamente significativas.

En la segunda fase, los participantes puntuaron más en las escalas de apatía (empeoramiento) y no se hallaron diferencias entre los grupos terapéuticos. Una posible explicación podría ser que la apatía de las personas institucionalizadas con demencia avanzada parece aumentar con el tiempo (79) y las intervenciones terapéuticas podrían tener una ventana en la demencia leve y moderada, pero no en la demencia grave (80). Aunque se aprecia un menor empeoramiento en el grupo PERRO, éste no es significativo (PERRO: 0,25 ± 3,55; p=0,984).

Estudios previos, a pesar del poco rigor metodológico, indican que las intervenciones no farmacológicas podrían reducir la apatía en la demencia (81). De hecho, Motomura et al (82) observaron una reducción significativa en las escalas de apatía aplicadas antes y después de la terapia animal (19,4 ± 3,7 vs 14 ± 3,5; p=0,05) mediante una escala de cinco preguntas de 0 a 25 puntos cada una en 8 mujeres diagnosticadas de demencia tras 4 sesiones de 1 hora con dos perros. Si bien, Moyle et al (83) tras el uso de PARO en un grupo de 18 personas con demencia durante 5 semanas no detectaron diferencias significativas en apatía.

En este estudio no se observó mejoría estadísticamente significativa en la apatía de los participantes. Aunque se apreció una tendencia a la mejora de la apatía tras el uso de NAO y cierta estabilidad en el grupo PERRO, siendo recomendable aumentar la muestra para analizar si dichas tendencias se repiten y alcanzan la significación estadística.

Otros síntomas neuropsiquiátricos

El análisis de las puntuaciones en los ítems del NPI mostró todo tipo de cambios mínimos.

Los cambios se observaron en los siguientes ítems, siendo los ítems en negrilla los que permanecen estadísticamente significativos tras la corrección de Benjamini-Hochberg:

- el grupo NAO:
    - empeoramiento en: **delirios** (fase 1),
    - mejoría en: apatía (fase 1),
- el grupo PARO:
    - empeoramiento en:
        - **alucinaciones** (fase 2)
        - **desinhibición** (vs el grupo PERRO)
        - ***irritabilidad*** (fase 1) y (fase 2)

    - mejoría en: **trastorno del comportamiento nocturno** (vs el grupo PERRO).

- el grupo PERRO:
    - empeoramiento en:
        - **(alucinaciones)** (fase 2)
        - ***irritabilidad*** (fase 2)

Delirios

Los delirios, o las ideas delirantes, en el grupo NAO mostraron un empeoramiento significativo (CONTROL: -0,48 ± 1,54; NAO 1,33 ± 3,31; p=0,011), si bien el grupo CONTROL presentó leve mejoría. En cambio, en la segunda fase se observó un aumento en las puntuaciones del ítem delirios del NPI en el grupo CONTROL y en el grupo PARO, mientras que apenas cambiaron en el grupo PERRO (CONTROL: 0,88 ± 3,52; PARO 0,67 ± 2,79; PERRO 0,11 ± 2,99), aunque los cambios fueron inferiores a un punto y no alcanzaron la significación estadística.

El ajuste terapéutico, que se produjo más en el grupo NAO (26,7%) que en los otros dos grupos, podría explicar este aumento en los delirios dado que algunas medicaciones psicoactivas pueden ocasionar cierta confusión mental en su introducción o en su retirada. Si bien lo más habitual es que los delirios ocasionen el ajuste terapéutico.

Los delirios se asocian al deterioro cognitivo más grave o al más rápido (se cree que es debido a un desequilibrio entre una neurotransmisión colinérgica deficiente y una monoaminérgica preservada o aumentada a nivel cortical) (84). Este hecho podría explicar porque en el grupo NAO, que presentó mayor declive en el MMSE (CONTROL: -0,52 ± 1,77; PARO -0,56 ± 1,86; NAO -1,12 ± 2,72; p=0,022), los usuarios presentaron más delirios que en los otros grupos (si bien el sMMSE se mantuvo prácticamente estable (CONTROL: -0,94 ± 2,62; PARO -0,09 ± 3,4; NAO 0,03 ± 4,59)).

Alucinaciones

Los cambios observados en las alucinaciones, si bien fueron estadísticamente significativos, podrían ser debidos más a una mejoría en el grupo CONTROL que a un empeoramiento en los grupos PARO y PERRO que se mantuvieron prácticamente estables (CONTROL: -1,34 ± 3,16; PARO 0,17 ± 1,75; PERRO 0,31 ± 1,31; p C-P=0,020; p C-D=0,004; p P-D=0,625). Por dicho motivo están indicados entre paréntesis en el resumen de los hallazgos en la escala NPI.

Agitación

Las diferencias observadas entre grupos terapéuticos en las puntuaciones del ítem agitación del NPI en el seguimiento no fueron estadísticamente significativas. Únicamente se apreció un leve aumento en los grupos de ambos robots respecto al grupo control, inferior a un punto y sin significación estadística (Fase 1: CONTROL: 0,48 ± 2,67; PARO 0,71 ± 3,47; NAO 1,42 ± 3,21; Fase 2: CONTROL: 0,28 ± 4,2; PARO 0,76 ± 3,38; PERRO 0,53 ± 3,88; p C-P=0,204; p C-D=0,429; p P-D=0,587).

En la terapia con animales, se ha descrito el descenso en la agitación en varios estudios (36,38,95). Richeson 2003 (38) realizó visitas con perros durante tres semanas y observó un descenso significativo de la agitación en las quince personas con demencia que participaron en la terapia con animales, si bien describió un aumento en la agitación tras finalizar la terapia.

En el uso de robots sociales, también se ha descrito una reducción en la agitación (71,83,99). Libin and Cohen-Mansfield (71) usaron un gato robot (NeCoRo) y un gato de peluche en el tratamiento de 9 personas con demencia y agitación. Ambos redujeron la agitación (el peluche de manera estadísticamente significativa) y aumentaron el interés y el placer (el robot de manera significativa desde el punto de vista estadístico).

En este estudio no se observó una mejoría, sino un leve empeoramiento en la agitación de los participantes. Quizás si la evaluación hubiera sido durante las sesiones y no a su término se hubiera apreciado el descenso en la agitación descrito en la literatura, siguiendo las observaciones de Richeson (38).

Depresión

Los cambios observados en la depresión no fueron estadísticamente significativos. Se halló un leve empeoramiento en la depresión, que ya estaba descrito en la evolución de la demencia (llegando incluso a aumentar su prevalencia en una muestra del 29% al 41-47% en sólo 5 años) (85). Salvo en el grupo PARO, donde la sintomatología depresiva permaneció estable en el seguimiento durante las dos fases del estudio.

En la terapia con animales, se ha investigado su eficacia frente los síntomas depresivos de las personas con demencia. Algunos estudios han descrito mejoría (86,87). En el estudio de Moretti et al (72), por ejemplo, ambos grupos, el de terapia animal y el grupo control, mejoraron en la escala de depresión, si bien en el grupo de terapia animal fue significativa ($p=0,013$). En cambio, otros estudios no observaron cambios significativos (21,82,88,89) con la terapia animal.

En el uso de robot mascota, Wada et al (78) tampoco apreció diferencias significativas en la escala de depresión tras realizar una experiencia a 12 mujeres mayores con demencia.

Ansiedad

Los cambios observados en la ansiedad no fueron estadísticamente significativos. En la fase 1 se apreció una estabilidad en el grupo PARO en cuanto a la ansiedad de los usuarios (PARO: $0,03 \pm 2,8$, $p=0,475$), si bien en la fase 2 se halló un leve empeoramiento (PARO: $0,64 \pm 3,38$, $p=0,530$). En el grupo NAO se observó un empeoramiento de aproximadamente medio punto (NAO: $0,48 \pm 3,62$, $p=0,431$), al contrario que en el grupo PERRO, donde las personas con demencia presentaron una leve mejoría en las puntuaciones del ítem de ansiedad en el seguimiento (PERRO: $-0,39 \pm 3,80$, $p=0,783$).

En la terapia con animales, Mossello E et al (73) observaron un descenso en el ítem de ansiedad de dicha escala (animal: 1,5 ± 2,7 vs peluche: 3,1 ± 2,3, p=0,04) a pesar de que no observaron cambios en la NPI total tras el uso de dos perros en un grupo de 10 personas con EA durante tres semanas. Kanamori et al (70) también describieron dicho descenso en escalas específicas de ansiedad (p=0,004) tras un ensayo controlado con 7 personas con demencia que realizaron seis sesiones con un perro o un gato. Estos hallazgos coinciden con la leve mejoría observada en el grupo PERRO.

En el uso de los robots sociales, también ha sido descrita tras el uso de PARO una mejoría en el comportamiento, definida como una reducción en la ansiedad y la agresividad (90). Moyle et al (83) no hallaron diferencias en una escala específica de ansiedad tras 5 semanas de terapia con PARO, si bien la muestra sólo contaba con 18 personas. En este estudio el grupo del robot PARO mantuvo o empeoró levemente en las puntuaciones del ítem de ansiedad, mientras que el grupo del robot NAO empeoró de forma leve, si bien dichos cambios no fueron estadísticamente significativos.

Euforia

Los cambios observados en la euforia o júbilo no fueron estadísticamente significativos. La euforia es un síntoma poco habitual en la demencia neurodegenerativa y sólo se apreció en el grupo CONTROL de la fase 1 (CONTROL: 0,36 ± 1,83, p=0,177), y en el grupo PERRO de la fase 2 (PERRO: 0,22 ± 0,93, p=0,076). No se hallaron resultados previos similares en la literatura.

Desinhibición

En la fase 1, todos los grupos terapéuticos presentaron un leve empeoramiento de la desinhibición (CONTROL: 0,94 ± 2,61; PARO 0,85 ± 2,26; NAO 1 ± 3,01) sin apreciarse diferencias significativas entre grupos. En la fase 2, se produjo un leve empeoramiento de la desinhibición en el grupo PARO, mientras que en el grupo PERRO no se apreciaron cambios, siendo la diferencia entre ambos grupos estadísticamente significativa (CONTROL: 0,63 ± 4,21; PARO 1,48 ± 3,42; PERRO -0,03 ± 2,82; p P-D=0,026). Merece la pena destacar la estabilidad de la desinhibición en el grupo PERRO, que no mostró cambios en el seguimiento, a pesar de que en el resto de grupos empeoró.

La desinhibición es frecuente en las personas con demencia moderada, como las que componen esta muestra. En ocasiones, la desinhibición es causada por el consumo de benzodiacepinas, antidepresivos tricíclicos e inhibidores selectivos de la recaptación de la serotonina, siendo extraña en antipsicóticos (91). Y es justamente en el grupo PARO donde se observaron más cambios farmacológicos y ajustes de dosis (33%). Aunque es un síntoma que puede fluctuar a lo largo de la evolución de la demencia, se ha descrito un aumento en su prevalencia a lo largo del seguimiento (85). En la literatura no se hallaron resultados similares tras el uso de animales o robots sociales.

Irritabilidad

Las medidas de irritabilidad en el ítem del NPI en la evaluación basal de la fase 2 mostraron diferencias significativas entre grupos (ver página 71), arrojando dudas sobre el significado de los resultados tras el seguimiento (texto en cursiva). Así que únicamente sería destacable el aumento de la irritabilidad en el grupo PARO respecto al grupo CONTROL, si bien no es clínica ni estadísticamente significativo (CONTROL: -0,27 ± 2,89; PARO 0,62 ± 2,56; p=0,033).

En la terapia con animales, Zisselman et al (88) observaron que 58 personas con demencia presentaban menor irritabilidad tras una sesión, sin embargo Motomura et al (82) y Naoyasu et al (101) no hallaron diferencias significativas en irritabilidad tras exponer a 8 mujeres con demencia a 4 sesiones de 1 hora de duración. En la literatura no se hallaron resultados similares tras el uso de robots sociales.

Movimiento errático

Los cambios observados en el movimiento errático, conducta motriz anómala o conducta motora sin finalidad, no fueron estadísticamente significativos. En la fase 1, se observó una mejoría del comportamiento o movimiento errático en el grupo CONTROL y en el grupo PARO, manteniéndose estable en el grupo NAO (CONTROL: -1,48 ± 4,53; PARO -0,35 ± 4,19; NAO 0,09 ± 3,78; p C-P= 0,185; p C-N= 0,075; p P-N=0,647). En la fase 2, en cambio, permaneció estable en el grupo CONTROL, pero empeoró en ambas herramientas experimentales (el grupo PARO y PERRO) (CONTROL: 0,06 ± 4,23; PARO 0,40 ± 4,47; PERRO 1,06 ± 3,40; p C-P= 0,724; p C-D= 0,161; p P-D=0,263).

En la literatura no se hallaron estudios que describieran cambios en el movimiento o el comportamiento errático tras el uso de animales o robots sociales. Únicamente Mossello et al (73) indicaron un aumento en la actividad motora durante la terapia con animales, si bien no apreciaron cambios en la escala NPI.

Trastorno del sueño o del comportamiento nocturno

En la fase 1, se observó una leve mejoría en el comportamiento nocturno en el grupo NAO, mientras que prácticamente permaneció estable en el resto de grupos (CONTROL: 0,18 ± 3,13; PARO 0,26 ± 2,68; NAO -0,42 ± 2,95; p C-P= 0,636; p C-N= 0,269; p P-N=0,105). En la fase 2, los trastornos del comportamiento nocturno presentaron una mínima mejoría en el grupo PARO mientras que en el grupo PERRO se mantuvieron estables (CONTROL: 0,41 ± 3,69; PARO -0,88 ± 2,27; PERRO 0,06 ± 2,78; p P-D=0,028).

En la terapia con animales, Thodberg et al (33) describieron que las personas que recibieron la visita de un perro durmieron más tiempo que los que fueron visitados por PARO o por un peluche. En cambio en nuestro estudio el grupo PERRO se mantuvo estable mientras que el grupo que presentó mejoría fue el grupo PARO. En la literatura no se hallaron estudios que describieran cambios en el comportamiento nocturno tras el uso de robots sociales.

Trastorno en la alimentación

Los cambios observados en los trastornos en la alimentación, apetito o desórdenes alimentarios, no fueron estadísticamente significativos. En la fase 1, se observó una estabilidad en la puntuación de dicho ítem de la escala NPI en el grupo CONTROL, mientras que el grupo PARO y el grupo NAO aumentaron sus puntuaciones indicando un empeoramiento (CONTROL: 0,03 ± 4,92; PARO 0,85 ± 3,60; NAO 0,52 ± 4,54; p C-P= 0,640; p C-N= 0,832; p P-N=0,461). En la fase 2, el grupo CONTROL empeoró, mientras que el grupo PARO y PERRO mantuvieron puntuaciones similares (CONTROL: 1,31 ± 4,45; PARO 0 ± 4,88; PERRO -0,19 ± 4,32; p C-P= 0,267; p C-D= 0,135; p P-D=0,684).

En la literatura no se ha hallado estudios que describan el cambio observado en la alimentación tras el uso de perros o robots sociales, únicamente el estudio de Thodberg et al (33) no hallaron diferencias en el peso de los usuarios tras la terapia con animales.

Cambios en el tratamiento

La mayoría de los participantes en el estudio mantuvieron estable su medicación psicoactiva (75,3% en la fase 1 y 82,98% en la fase 2). El médico geriatra del CAFRS trata en todo momento de reducir el tratamiento farmacológico de los residentes, dados sus posibles efectos adversos en las personas mayores (92,93). Así se observa que la mayor parte de los cambios consisten en una reducción en la dosis o supresión farmacológica (63,88%). Es por dicho motivo destacable el aumento de tratamiento en el grupo NAO (16,7% del grupo) y PARO en la fase 2 (14,2%) aunque dicho aumento sólo afecta a 5 y 4 personas respectivamente (siendo en una de ellas la introducción de un hipnótico).

En el estudio de Petersen et al (94) describen un descenso de las dosis del tratamiento prescrito para los trastornos del comportamiento y la depresión tras 3 meses de sesiones de 20 minutos de duración con PARO en un grupo de 35 personas con demencia leve-moderada. Si bien no queda claro si en el descenso de las dosis se ha tenido en cuenta el principio activo prescrito o la significación clínica del descenso.

McCabe et al. (95) observaron un descenso de los síntomas comportamentales de las 22 personas con demencia tras el uso de un perro de terapia por la mañana durante un mes ($p<0.05$), no observando cambios en los síntomas en las sesiones realizadas por la tarde ni de la medicación pautada para dichos síntomas.

Cambios en la calidad de vida

La calidad de vida, medida con la escala QUALID para familiares, no presentó diferencias significativas en la primera fase. Si bien se apreció una tendencia a empeorar la CV en el grupo PARO respecto a los otros dos grupos y a mejorar en el grupo NAO (grupo CONTROL: 0,33 ± 5,22; grupo PARO: 3,57 ± 6,41; p C-P=0,174; grupo NAO: -0,85 ± 5,97; p C-N=0,576; p P-N= 0,062) (ver tabla 6). En la segunda fase, los voluntarios que recibieron la terapia con el robot mascota también mostraron un empeoramiento (1,31 ± 7,52), mientras que quienes participaron en las sesiones con la terapia habitual mejoraron ligeramente (-2,8 ± 5,79), siendo las diferencias observadas entre grupos estadísticamente no significativas tras la corrección de Benjamini-Hochberg (p=0,044) (ver tabla 7).

En varios estudios de la literatura se describe mejoría en la calidad de vida de las personas mayores con deterioro cognitivo tras el uso de animales y robots. Moretti et al (72) observaron un efecto positivo en la calidad de vida de las personas tras realizar terapia con animales, si bien no fue estadísticamente significativo. Moyle et al (83) hallaron mejoría estadísticamente significativa en la calidad de vida en un ensayo clínico piloto aleatorizado en el que participaron 18 personas con demencia que interactuaron con PARO durante 5 semanas (3 veces por semana). Un robot social, AIBO, se usó durante siete semanas en una residencia de personas mayores con incapacidad y observaron un aumento significativo en su calidad de vida (70). E incluso en 2009, Tapus et al. (96) propusieron un protocolo para usar los robots sociales para mejorar la calidad de vida de las personas con demencia a través de la motivación, estimulación y compañía de los usuarios.

En este estudio, no se hallaron diferencias entre grupos de tratamiento estadísticamente significativas respecto a la calidad de vida de los participantes. En todo caso, se podría afirmar que el uso del robot PARO en las sesiones de terapia ocupacional derivó en una tendencia al empeoramiento en las puntuaciones de la escala de calidad de vida.

Diferencias entre herramientas

Una de las hipótesis del estudio fue que el robot humanoide mejoraría en mayor medida los trastornos del comportamiento y la calidad de vida respecto al robot mascota. El uso del lenguaje oral, así como la capacidad de desplazarse y realizar movimientos similares a los del terapeuta se consideraron más adecuados a tal fin. Si bien esta hipótesis se demostró falsa al no observar diferencias significativas en el cambio observado en las variables del estudio entre ambos grupos en el seguimiento.

Algunos autores defienden que a las personas con deterioro cognitivo les resulta más sencillo la interacción directa y confían más en el lenguaje no corporal que en la comunicación verbal (97). Es de destacar que la muestra de este estudio se compone de personas con demencia avanzada (moderada-grave) siendo la afasia común en esta fase de la enfermedad (98). Por tanto, muchos de nuestros usuarios no se habrían beneficiado del uso del lenguaje oral y, en el caso del robot humanoide, dicho lenguaje apenas se acompaña de comunicación no verbal.

En las escalas que evalúan la calidad de vida y las alteraciones del comportamiento (NPI y APADEM-NH) se observó que en el grupo NAO los participantes puntuaron mejor que en el grupo PARO en la evaluación de seguimiento en: total de la escala QUALID; déficit de pensamiento, inercia cognitiva, total de la escala APADEM-NH; alucinaciones, apatía, euforia, irritabilidad, trastornos del sueño y de la alimentación. Aunque en el total de la escala NPI la mejoría fue mayor en el grupo PARO que en el grupo NAO

(PARO: 1,97 ± 12,44; NAO 3,52 ± 16,07; p=0,782). Sería interesante aumentar el tamaño de la muestra para ver si estos mínimos cambios se repiten y llegan a alcanzar la significación estadística.

Otra de las hipótesis del estudio era que el animal mejoraría en mayor medida los trastornos del comportamiento y la calidad de vida respecto al robot mascota. En este estudio, las personas del grupo de terapia animal puntuaron mejor que las personas del grupo PARO respecto al ítem desinhibición de la escala NPI, siendo la diferencia entre grupos estadísticamente significativa.

El resto de diferencias observadas entre el grupo PARO y el grupo PERRO, no alcanzaron la significación estadística. Si se observa la media del cambio en las puntuaciones de las escalas NPI y APADEM-NH (las escalas que recogen los trastornos del comportamiento) se aprecia que las personas que realizaron la terapia con el animal en el seguimiento puntúan mejor que quienes estuvieron con PARO en: APADEM-NH total, déficit de pensamiento, inercia cognitiva, NPI total, delirios, agitación, ansiedad, apatía, desinhibición, irritabilidad y trastornos de la alimentación. También puntúan mejor en la escala QUALID y en el sMMSE. Sería interesante aumentar el tamaño de la muestra para ver si estos mínimos cambios se repiten y llegan a alcanzar la significación estadística.

Limitaciones del estudio

Este proyecto es un proyecto exploratorio, lo que conlleva un bajo número de participantes y un alto número de comparaciones entre grupos. Al plantear el estudio se esperaba una menor participación, siendo finalmente superado el número de participantes de la mayoría de estudios previos de introducción de animales o robots sociales en la terapia de personas con demencia. En cuanto al elevado número de comparaciones realizadas, se estimó prioritario explorar tendencias en varias escalas que centrarnos en una sola escala. En un futuro, tras las tendencias observadas en este estudio, se podrán diseñar estudios más específicos (pocas variables) y con mayor muestra.

En el diseño del estudio se trataron de minimizar posibles sesgos:

- Se realizaron tres meses de terapia (12 semanas) para reducir el efecto novedad igualando o superando la duración de la mayoría de estudios realizados con anterioridad
- Las rutinas, la terapia, los terapeutas… no se modificaron, salvo la introducción de las nuevas herramientas, para tratar de minimizar el efecto Hawthorne y evitar la introducción de posibles sesgos.
- Los evaluadores y el estadístico fueron ciegos y realizaron evaluaciones antes y después de este estudio, no alterando así la rutina del centro.
- Varias sesiones fueron grabadas con cámaras antes del inicio del estudio para que tanto los participantes como los terapeutas se acostumbraran a su presencia y así tratar de reducir el efecto Hawthorne
- La interacción entre los cuidadores y los robots o los perros se evitaron para reducir el sesgo del informador
- Se estimuló la participación activa de los participantes para tratar de reducir un sesgo de selección, si bien no se forzó la interacción con el terapeuta o con las herramientas.

Los participantes de este estudio provienen en su totalidad de un único centro, el Centro Alzheimer Fundación Reina Sofía. Si bien la muestra no es representativa de la población general, debemos aclarar que el ingreso en dicho centro se realiza siguiendo las directrices generales de la Comunidad de Madrid.

La aleatorización fue realizada por unidades de vida o edificios, no por cada uno de los individuos. Si bien la aleatorización individual hubiera sido la óptima, habría comportado el traslado de los residentes a otras unidades o edificios siendo inconveniente para algunos de los residentes (agrupaciones familiares o dificultad para el desplazamiento). Además, el ambiente y las características de los personas de cada una de las unidades de una misma gravedad son muy similares. La evaluación basal no mostró diferencias en las variables entre grupos en la residencia (salvo en el ítem irritabilidad de la escala NPI de la fase 2), indicando que no había diferencias significativas entre las personas que vivían en las diferentes unidades en relación a las variables analizadas en este estudio.

A lo largo del estudio, varios participantes fallecieron antes de la primera aleatorización (16 personas) o durante el periodo de lavado (12 personas), un voluntario retiró el consentimiento y un voluntario sólo fue evaluado en una ocasión por ausencia del centro por vacaciones. Siendo así muy baja la pérdida de seguimiento tras la aleatorización de los participantes (únicamente una persona), hecho remarcable dado el grado de evolución de la demencia de la mayoría de participantes de este estudio.

Futuras investigaciones

Cuando se planteó la realización de este estudio, no se hallaron en la literatura comparaciones entre distintos robots o comparaciones de PARO con un animal en el tratamiento no farmacológico de las personas con demencia. La metodología de los estudios por aquel entonces publicados era poco robusta y no permitía su reproducción, si bien describían resultados alentadores.

En la actualidad, empiezan a aparecer estudios en la literatura médica con una metodología más sólida: aleatorización, grupo control, mayor número de participantes, escalas de medida estandarizadas y validadas (102)… Estos estudios permitirán determinar si los hallazgos aquí descritos se repiten y, en caso de tener un mayor número de participantes, si alcanzan la significación estadística.

Así mismo, también sería conveniente introducir este tipo de herramientas en la terapia no farmacológica de personas con demencia leve-moderada y analizar los cambios observados respecto a los hallazgos en personas con demencia avanzada.

CONCLUSIONES

CONCLUSIONES

De acuerdo con los resultados obtenidos en el presente estudio, las conclusiones son las siguientes:

1. Los robots sociales y los animales utilizados en una muestra de personas con demencia avanzada institucionalizadas son bien aceptados y pueden ser fácilmente incluidos en el modelo de terapia ocupacional convencional, adaptándose al grado de afectación de la persona.

2. La utilización de robot humanoide, robot mascota y perro no indujo cambios significativos en los trastornos del comportamiento ni mejoría en la calidad de vida de los participantes. No obstante, la medicación psicoactiva prescrita se mantuvo prácticamente estable.

3. En la comparación del efecto de las terapias entre sí, robot mascota con robot humanoide y robot mascota con animal, las diferencias observadas entre los distintos tipos de terapia no llegaron a alcanzar significación estadística (salvo la mejoría de la desinhibición en el grupo animal respecto al grupo robot mascota).

4. Por tanto, en el momento actual y en base a los resultados del presente estudio, no hay evidencia que permita avalar la recomendación de usar sistemáticamente estas herramientas en la terapia ocupacional de las personas con demencia avanzada. Son necesarios estudios adicionales, con un mayor tamaño muestral y pacientes en fases menos graves de demencia, antes de descartar su utilidad para mejorar la calidad de vida y los trastornos del comportamiento en personas con deterioro cognitivo.

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ANEXO I

ANEXO I

En el anexo I se incluyen todas las convocatorias públicas competitivas, publicaciones y comunicaciones a congresos de este estudio.

CONVOCATORIAS PÚBLICAS COMPETITIVAS

2011	Obtención convocatoria subvención pública competitiva del Ministerio de Salud, Política Social e Igualdad (IMSERSO 231/2011)
2010	Obtención convocatoria subvención pública competitiva del Ministerio de Ciencia e Innovación (FIS PI10/02567)

PUBLICACIONES

2015	**Valentí Soler Meritxell**, Agüera-Ortiz Luis, Olazarán Rodríguez Javier, Mendoza Rebolledo Carolina, Pérez Muñoz Almudena, Rodríguez Pérez Irene, Osa Ruiz Emma, Barrios Sánchez Ana, Herrero Cano Vanesa, Carrasco Chillón Laura, Felipe Ruiz Silvia, López Alvarez Jorge, León Salas Beatriz, Cañas Plaza José, Martín Rico Francisco, Martínez Martín Pablo. Social robots in advanced dementia. Frontiers in Aging Neuroscience. VOL (7) 2015 DOI=10.3389/fnagi.2015.00133 ISSN=1663-4365 URL =http://journal.frontiersin.org/article/10.3389/fnagi.2015.00133
2013	F.Martín, J.M.Cañas, G.Abella, P.Martínez, **M.Valenti.** Robots applied to dementia: a practical experience. Proceedings of RoboCity2030 11th Workshop, Robots sociales, pp 193-203, U. Carlos III, March 14, 2013. ISBN:978-84-695-7212-2 (http://gsyc.es/jmplaza/papers/robocity2013-robotherapy_experience.pdf]
	F.Martín, C.Agüero, J.M.Cañas, G.Abella, R.Benítez, S.Rivero, **M.Valenti**, P.Martínez-Martín. Robots in Therapy for Dementia Patients [Journal] Journal of Physical Agents. Volume 7, Number 1, pp 48-55, 2013. ISSN: 1888-0258.(http://gsyc.es/jmplaza/papers/2013-jopha-robots_dementia_therapy-published.pdf)
	Francisco Martín, Carlos E. Agüero, José María Cañas, **Meritxell Valenti** and Pablo Martínez-Martín. Robotherapy with Dementia patients International Journal of Advanced Robotic Systems, Vol 10, 10. INTECH, 2013.DOI: 10.5772/54765 ISSN 1729-8806 (http://www.intechopen.com/journals/international_journal_of_advanced_robotic_systems/robotherapy-with-dementia-patients)
2012	Francisco Martín, Carlos Agüero, José M. Cañas, Gonzalo Abella, Raúl Benítez, Sergio Rivero, Pablo Martínez-Martín, **Meritxell Valenti.** Robotherapy with Alzheimer patients. Proceedings of XIII Workshop on Physical Agents, WAF-2012, Santiago de Compostela, 3rd-4th september 2012. pp 99-104, ISBN 978-84-940469-0-2, 2012

COMUNICACIONES A CONGRESOS

INTERNACIONALES	2013	**Meritxell Valentí**, Carolina Mendoza, Gonzalo Abella, Luis Agüera, Jorge López, Belén Frades, Marina Ávila, Miguel Fernández, Beatriz León, Javier Olazarán, Francisco Martín, José Cañas, Pablo Martínez-Martín and MSU. Robotherapy in dementia: pilot study. International Conference on Alzheimer's Disease - ICAD 2013. Accepted but not presented for economic reasons.
		Meritxell Valentí, Carolina Mendoza, Gonzalo Abella, Luis Agüera, Jorge López, Belén Frades, Marina Ávila, Miguel Ángel Fernández, Beatriz León, Javier Olazarán, Francisco Martín, José María Cañas, Pablo Martinez-Martin and MSU. Robotherapy in dementia: pilot study. XXIII Meeting of the European Neurological Society. 8-11 June 2013, Barcelona, Spain
	2011	**Meritxell Valentí Soler**, Francisco Martín Rico, Beatriz León Salas, Luis Agüera Ortiz, Isabel Ramos García, Javier Olazarán Rodríguez, Pablo Martínez Martín and UMA group. Robotherapy in moderate dementia: pilot study. Global Alzheimer's Research Summit, Madrid 2011
NACIONALES	2013	**M. Valentí Soler**, L. Carrasco Chillón, C. Mendoza Rebolledo, E. Huélamo Sáez, G. Abella Yago, J.M. Cañas Plaza y P. Martínez Martín. Roboterapia en demencia: estudio piloto en centro de día. LXV Reunión anual de la Sociedad Española de Neurología. Barcelona, 19-23 Noviembre 2013.
		M. Valentí Soler, C. Mendoza Rebolledo, G. Abella Yago, L. Agüera Ortiz, J. López Álvarez, B. Frades Payo, M. Ávila Villanueva, M.A. Fernández Blázquez, B. León Salas, J. Olazarán Rodríguez, F. Martín Rico, J.M. Cañas Plaza y P. Martínez Martín. Roboterapia en demencia: estudio piloto en residencia. LXV Reunión anual de la Sociedad Española de Neurología. Barcelona, 19-23 noviembre 2013.
	2012	Robótica en la recuperación de Alzheimer. Ponencia (http://gsyc.es/jmplaza/papers/vodafone-2012.pdf)
		M. Valentí Soler, F. Martín Rico, P. Martínez Martín, C. Mendoza Rebolledo, B. León Salas, G. Abella Dago, L. Agüera Ortiz, I. Cruz Orduña, I. Ramos García, J.M. Cañas Plaza, B. Frades Payo y M. Ávila Villanueva. Roboterapia en demencia. LXIV Reunión anual de la Sociedad Española de Neurología. Barcelona, 20-24 noviembre 2012.
	2011	Robótica en la recuperación de Alzheimer (http://gsyc.es/jmplaza/papers/uleon-2011.pdf)
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Social robots in advanced dementia

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Aims: Pilot studies applying a humanoid robot (NAO), a pet robot (PARO) and a real animal (DOG) in therapy sessions of patients with dementia in a nursing home and a day care center.

Methods: In the nursing home, patients were assigned by living units, based on dementia severity, to one of the three parallel therapeutic arms to compare: CONTROL, PARO and NAO (Phase 1) and CONTROL, PARO, and DOG (Phase 2). In the day care center, all patients received therapy with NAO (Phase 1) and PARO (Phase 2). Therapy sessions were held 2 days per week during 3 months. Evaluation, at baseline and follow-up, was carried out by blind raters using: the Global Deterioration Scale (GDS), the Severe Mini Mental State Examination (sMMSE), the Mini Mental State Examination (MMSE), the Neuropsychiatric Inventory (NPI), the Apathy Scale for Institutionalized Patients with Dementia Nursing Home version (APADEM-NH), the Apathy Inventory (AI) and the Quality of Life Scale (QUALID). Statistical analysis included descriptive statistics and non-parametric tests performed by a blinded investigator.

Results: In the nursing home, 101 patients (Phase 1) and 110 patients (Phase 2) were included. There were no significant differences at baseline. The relevant changes at follow-up were: (Phase 1) patients in the robot groups showed an improvement in apathy; patients in NAO group showed a decline in cognition as measured by the MMSE scores, but not the sMMSE; the robot groups showed no significant changes between them; (Phase 2) QUALID scores increased in the PARO group. In the day care center, 20 patients (Phase 1) and 17 patients (Phase 2) were included. The main findings were: (Phase 1) improvement in the NPI irritability and the NPI total score; (Phase 2) no differences were observed at follow-up.

Keywords: dementia, Alzheimer disease, therapy, robotics, human-robot interaction, technology, animal assisted therapy, apathy

Introduction

Dementia, including Alzheimer's disease, is expected to affect to 75.62 million people by 2030 and 135.46 million by 2050. The prevention and treatment of secondary causes of dementia (hypothyroidism, vitamin B12 deficiency, Lyme disease, neurosyphillis. . .) and the control of risk factors (smoking, underactivity, obesity, hypertension, diabetes, lack of education. . .) may decrease the incidence (Prince et al., 2013). Research focused on finding a cure for dementia is key, but in the meantime, we must bear in mind that patients with dementia need the most appropriate treatment. New drugs and non-pharmacological treatments are currently being researched.

Animal-assisted therapy (AAT), the use of animals in therapy sessions, is one such non-pharmacological tool currently under investigation. The Cochrane Database of Systematic Reviews published a protocol to study "AAT for people with serious mental illness" (Downes et al., 2013). In 2006, the British National Institute for Health and Clinical Excellence (NICE) published guidelines for people with dementia (Fairbairn, 2006) and included AAT as an approach that may be considered a non-pharmacological intervention for non-cognitive symptoms and behavior. AAT seems to calm agitated behavior and has positive effects on the quality of social interaction and mood disturbances, although no effect was observed on cognitive performance (Bernabei et al., 2013).The presence of an animal involves an increase in the frequency and duration of visual contact and smiles. Interaction with a real animal, rather than a stuffed one, increases the frequency of verbalization. Studies have shown a decrease in verbal aggression and agitation with reduced behavior problems, although the need for drug treatment was not changed. However, it has been observed that agitation increases when therapy with animals was withdrawn. The effect of animal therapy was independent of the severity of the dementia (Filan and Llewellyn-Jones, 2006).

However, AAT is not always possible. Animals are often not allowed in nursing homes or day care centers, due to the risk of injury to patients, staff or visitors, the possibility of allergic reactions, and the potential nuisance of cleaning up after the animals. Patients or staff may have undesired reactions to animals, both negative (i.e., Fear) and overly positive (i.e., becoming too attached). Aggressive patients could frighten or harm the animals. And the cost of animal care (space, time and money) might exceed the benefits of a few hours of therapy per day.

Thus, the alternative of replacing real animals with animal-shaped objects became an object of investigation (Nakajima et al., 2001). In recent years, social robots have been also used as reasonable substitutes for animals in therapy for people suffering from dementia (Wada et al., 2008; Shibata, 2012).

Robots have less needs for space, time, or care. Their sensors can respond to environmental changes (movements, sounds...) simulating interaction with the patient. They can monitor patients or be used in the therapy. Other potential benefits of therapy with robots are that there are no known adverse effects, specially trained personnel are not required and they can repeat the script in the same way as many times as it is required.

In 2009, a systematic review examining the literature on the effects of assistive social robots in health care for the elderly, especially in the role of providing companions for patients, was published (Broekens et al., 2009). The main conclusions were that most of the elderly people liked the robots and the robots can improve: health (by lowering levels of stress and increasing immune system response), mood (decreasing feelings of loneliness) and communication (increasing it). Moreover, the robots lessened the severity of dementia as measured by specific scales in some studies.

Bemelmans et al reviewed the literature in 2012 and found that the most of the studies reported positive effects of companion-type robots on (socio) psychological (e.g., mood, loneliness, and social connections and communication) and physiological (e.g., stress reduction) parameters (Bemelmans et al., 2012).

In the present study, animals and robots were added into the therapy sessions at a center for dementia patients. They were employed just as any other tool the therapists might use, in order to discover the potential effect of the tool without changes in the therapists' actions, the session content or the environment of the patients.

Objective

Pilot studies were carried out in order to test the effect of introducing a humanoid robot (NAO), a pet robot (PARO) and a real trained animal (DOG) in the therapeutic sessions for patients with dementia in relation to behavior changes, apathy and quality of life.

In a nursing home, where institutionalized patients with dementia are living in controlled conditions, the objective was to compare the effects of therapy sessions involving:

- (Phase 1) a humanoid robot (NAO), who is able to use oral language (phrases previously recorded) and move like a human; an animal-shaped robot (PARO), who does not use oral language but sounds and moves like an animal; and with conventional therapy (CONTROL).
- (Phase 2) a trained dog (DOG); an animal-shaped robot (PARO), who has been used as reasonable substitute for animals in therapy for people suffering from dementia; and with conventional therapy (CONTROL).

In a day care center, where dementia patients attend for 8 h a day approximately, the objective was to compare the baseline with the follow-up effects of therapy sessions involving the robots:

- (Phase 1) NAO and
- (Phase 2) PARO.

Materials and Methods

Patients

All dementia patients being cared for at the Alzheimer Center Reina Sofía Foundation (ACRSF) (Olazarán et al., 2012), a public nursing home and day care center, were invited to participate. All the participants, and their legal guardians or families, received information and signed an informed consent form approved by the CIEN Foundation Ethical Committee. Inclusion criteria were a diagnosis of neurodegenerative dementia, being cared for at ACRSF and possessing a signed consent form. Exclusion criteria were: fear of the robot or dog and severe acute illness (requiring hospitalization or intensive medical care).

Therapeutic Tools

The robots used in this study were:

PARO

A social robot with the appearance, movement and sounds of a baby seal. It has programmable behavior and sensors for posture, touch, sound, and light. Its eyes, which are big, black and with long eyelashes, can open and close; it can also move its neck (laterally and up-and-down), anterior flippers and tail. Although its movements are silent, it emits short and sharp squeals like a real seal. It is very soft and white in color, with hard Velcro covering the access to the mechanism (so it is not easy to access it during therapy sessions). It cannot move forward or change its sounds and weighs 2.7 kg.

NAO

A white humanoid robot, measuring 58 cm tall and weighing 4.3 kg. It has sensors for movement, touch, sonar, sound, and vision. It can talk and sing. It has a robotic voice, but it is possible to replace it with mp3 recordings of a child-like human voice that is easier for patients to understand. It can move its neck and arms, walk, or dance. Software was developed to allow the robot to act out a script for therapy sessions. These scripts included effects like speech, music and movements. During the therapy session, the therapist could control the activation of and progression through the script using remote control software installed in an Android device. The therapists were able to pause the script, repeat sections of it, or jump to another section. It was also possible to use this software to remotely operate the robot in order to make it walk or move its head (Martin et al., 2013).

The animals used were dogs: two adult black Labrador Retrievers. Both had received prior training for therapy. Each dog participated in half of the sessions with each group. The therapists received training prior to the sessions on the use of animals, and the animals were allowed to adapt to the Center before beginning the research activities. Therapists specially trained to work with animals attended all the sessions with the dogs, in order to monitor the course of therapy.

Otherwise, the tools used in the control group were the same as in the other two groups. It was necessary to adapt certain tools used in the sessions for its use with the robots and the dogs: specially designed vests with pockets and Velcro were produced, and flash cards were laminated.

Design

Nursing Home

A controlled clinical trial of parallel groups, randomized by blocks (living units) and stratified by dementia severity, comparing therapy with robots and dogs against standard care was carried out.

One hundred fifty six patients with dementia reside in the ACRSF nursing home. All patients receive similar care, in terms of: medical and custodial care, non-pharmacological therapy and personalized nutrition, therapy programming, and physical exercise. They live in similarly designed floors, with natural lighting and large spaces tailored to their needs. Residents live on different floors or living units depending on the severity of their dementia. The floors with patients of similar severity were grouped by threes: three floors of patients with mild-moderate dementia, three floors of patients with moderate-severe dementia, and three floors of patients with severe dementia. For each dementia severity group, each floor was randomly assigned to one of the three therapies (randomization by blocks). All the environmental conditions were controlled for, so that the specific tool used by the therapist in the sessions was the only difference in the sessions experienced by the different therapy groups.

The study had 2 year-long phases, carried out during two consecutive years (2012 and 2013), comparing two different modalities of experimental therapies to each other and to standard care. The therapies compared were:

- Phase 1: CONTROL, NAO (humanoid social robot), PARO (animal-esque social robot).
- Phase 2: CONTROL, PARO (animal-esque robot), DOG (real animal).

All the patients included were assigned to only one of the three therapeutic groups, worked with only one tool (Control, PARO, NAO, or DOG) and were evaluated before and after the study sessions. Randomization was performed before the baseline evaluations using a six-sided die.

Day Care Center

Forty people are cared for at the ACRSF day care center. A pretest-posttest design was used, due to the small number of participants and the inability to control the differences between their medical and nursing care, routines and nutrition. All patients participated in sessions with only one of the therapeutic tools: NAO in the first phase and PARO in the second. Patients were divided by the therapists in two therapeutic groups according to dementia severity: mild-moderate dementia and moderate-severe dementia.

Therapy

The therapy sessions were performed 2 days a week during 3 months.

All therapeutic sessions were conducted by the same therapist, with the same structure as the other therapeutic programs, at the same time of day and for the same duration of time (30–40 min).

The therapists were certified occupational and physical therapists, and neuropsychologists employed by the ACRSF. They received instructions on the implementation and possible uses of robots and animals as they had no previous expertise in this area. The animal therapists and robot engineers did not participate in the therapy; they only monitored the session from one side of the room, out of the patients' view. Session guides were written and followed in every session.

The therapists used the same model of standard therapy, introducing the experimental tools as one more element of the therapy. It is important to note that the object of investigation was the effect of the specific tools, not the effect of the therapy itself, so the tools had to be used for the same purpose and in the same way in the three therapeutic groups if possible. Only one robot or dog was used in every session.

The patient interacted with the robots, the animals and the therapists to perform several therapeutic activities, including: identifying numbers, words, and colors using flash cards; practicing the use of everyday objects such as combs; sensory stimulation exercises using different textured fabrics. . .

The robots and the animals were wearing specially designed vests with pockets and Velcro, in order to carry the objects used in the sessions, and move from patient to patient.

All sessions had the same overall structure: greeting the group, introduction, therapeutic exercises (cognitive or physical therapy) and ending.

The introduction included the presentation of the target tool, orientation activities (spatial, temporal, and personal orientation), and motivation to participate in the therapy session.

Therapeutic exercises were small units of activities, focused on the stimulation of memory, language, calculation, movement, praxis, and the use of the different senses. Activities involved physical exercises, questions and answers, music, videos, and manipulation or touching several objects. Between the exercises, there were brief pauses to encourage the collaboration and participation of all users.

At the end of the session, the therapists reviewed what the group did with everyone, asked whether or not they liked participating in the sessions, and lead the group in a farewell song.

Group sessions were employed for patients with mild or mild-moderate dementia, and individual sessions were used with patients with moderate-severe and severe dementia. The group sessions were conducted with 9–15 participants seated in a circle with the therapist and the tools in the inside, moving from patient to patient. In the individual sessions, the therapist was sitting in front of the patient, at the same level, providing stimuli one by one.

Sessions with four levels of difficulty were designed:

1. Mild difficulty level (performed with patients from the day care center). An extensive cognitive session was designed, and the therapist selected a different part of the session each day to avoid repetitiveness and the participants' boredom. The physical therapy session consisted of a complete set of exercises involving head, neck and upper and lower limbs. The robot was programmed to move faster, given the better physical condition of the majority of the patients from the day care center.
2. Mild-moderate level of difficulty. Three sessions were designed: therapy with music, cognitive therapy and physical therapy.
3. Moderate-severe difficulty level. Two sessions were designed: cognitive therapy and physical therapy.
4. Severe difficulty level. One session was designed using language stimulation, music, passive movement and sensory stimuli.

All therapy sessions were recorded on video for *post-hoc* observational analysis. Two cameras with tripods were used and were placed outside the circle formed by the patients. There were several recording sessions previous to the start of the study to get the patients and therapists used to its presence, thereby reducing the Hawthorne effect.

Assessments

Evaluation was carried out by blinded raters at baseline and follow-up using the following validated scales:

- The Global Deterioration Scale (GDS) (Reisberg et al., 1982), which was given by a neurologist,
- The Severe Mini Mental State Examination (sMMSE) (Harrell et al., 2000; Buiza et al., 2011) and the Mini Mental State Examination (MMSE) (Folstein et al., 1975; Lobo et al., 1999), which were given by a neuropsychologist,
- The Neuropsychiatric Inventory (NPI) (Cummings et al., 1994; Vilalta-Franch et al., 1999; Boada et al., 2005), the Apathy Scale for Institutionalized Patients with Dementia Nursing Home version (APADEM-NH) (Agüera-Ortiz et al., 2015), which was used with patients in the nursing home only, and the Apathy Inventory (AI) (Robert et al., 2002), which was used with patients from the day care center only, and was given by a psychiatrist,
- And the Quality of Life in Late-stage Dementia (QUALID) (Weiner et al., 2000; Garre-Olmo et al., 2010), which was given by a sociologist.

When the evaluations required interviewing the nursing staff about patient functioning, the raters interviewed the same staff members for each patient at baseline and follow up whenever possible.

Medical information was also collected for subsequent analysis. The wash-out period between phases was 9 months long.

Data Analysis

Statistical analysis, apart from descriptive statistics, included the Wilcoxon, Mann-Whitney and Kruskal-Wallis tests for comparisons, performed by a blinded researcher. Non-parametric tests were used as the data did not meet the assumptions for use of parametric statistics. The statistical analysis was done using Stata software (Stata©. Stata Corp., College Station, Texas, USA version: 15).

Results

All patients, families and legal guardians received written information and informational meetings were organized.

One hundred and forty eight people signed the informed consent forms. Before the first evaluation, 22 participants died, two people moved to another center and one person withdrew consent.

In the first experimental phase, two people suffered acute illnesses and did not complete the treatment. During the wash out period, 31 additional people signed the consent forms, 12 patients died, nine people moved to other centers and one person withdrew consent.

In the second experimental phase, three people did not complete the treatment due to illnesses or absences from ACRSF (**Figure 1**).

Nursing Home

Phase 1

In the first phase, 101 patients with moderate/severe dementia (GDS 4: 2%, GDS 5: 17%, GDS 6: 44% and GDS 7:37%), mean age 84.68 years old (range: 58–100 years), 88% of which were women, were included.

Dementia diagnosis was: 84.2% Alzheimer disease, 10.9% mixed dementia, 3% Parkinson's disease dementia, 1% dementia with Lewy bodies, 1% Frontotemporal dementia.

There were 38 people in the CONTROL group, 33 in the PARO group and 30 in the NAO group. Evaluation showed no significant differences between groups at baseline.

All groups showed a statistically significant increase in GDS scores, indicating a decreased functional level (Fisher's exact $<$ 0.000) at follow-up.

Scores on QUALID, sMMSE, and NPI (total score) showed no statistically significant changes between groups at follow-up (**Figure 2**).

In contrast, statistically significant differences were found after treatment in MMSE scores (a significant decrease in the NAO group), APADEM-NH scores (both the PARO and the NAO groups had significant decreases in total score, and the NAO group in cognitive inertia score), and several NPI items: delusions (a significant increase in the NAO group), apathy (a significant decrease in the NAO group) and irritability/lability (a significant increase in the PARO group) (**Figures 3**, **4** and **Table 1**).

There were no statistically significant differences between the NAO and PARO groups.

Phase 2

In the second phase, 110 patients with moderate/ severe dementia (GDS 5: 22%, GDS 6: 30%, and GDS 7: 48%), mean age 84.7

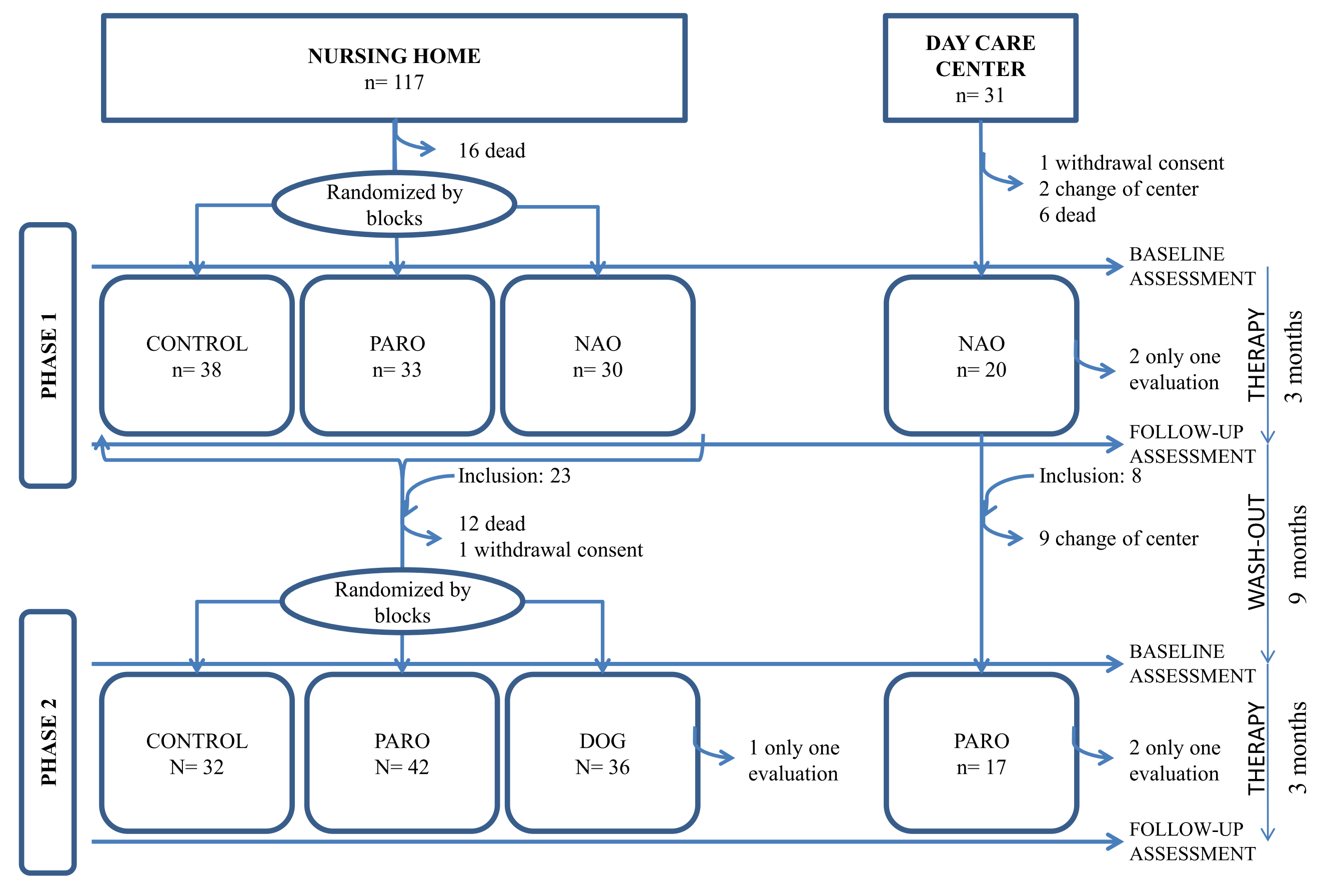

FIGURE 1 | All patients whose families/guardians gave consent and who fit inclusion/exclusion criteria were included. Therapy sessions: each group worked only with a tool (conventional, PARO, NAO, or DOG) in the nursing home; in the day care center all participants worked with NAO in the first phase, and PARO in the second. Assessments were realized before and after the study sessions. The wash-out period allowed the entry of new participants. Randomization was carried out before the study sessions only in the nursing home.

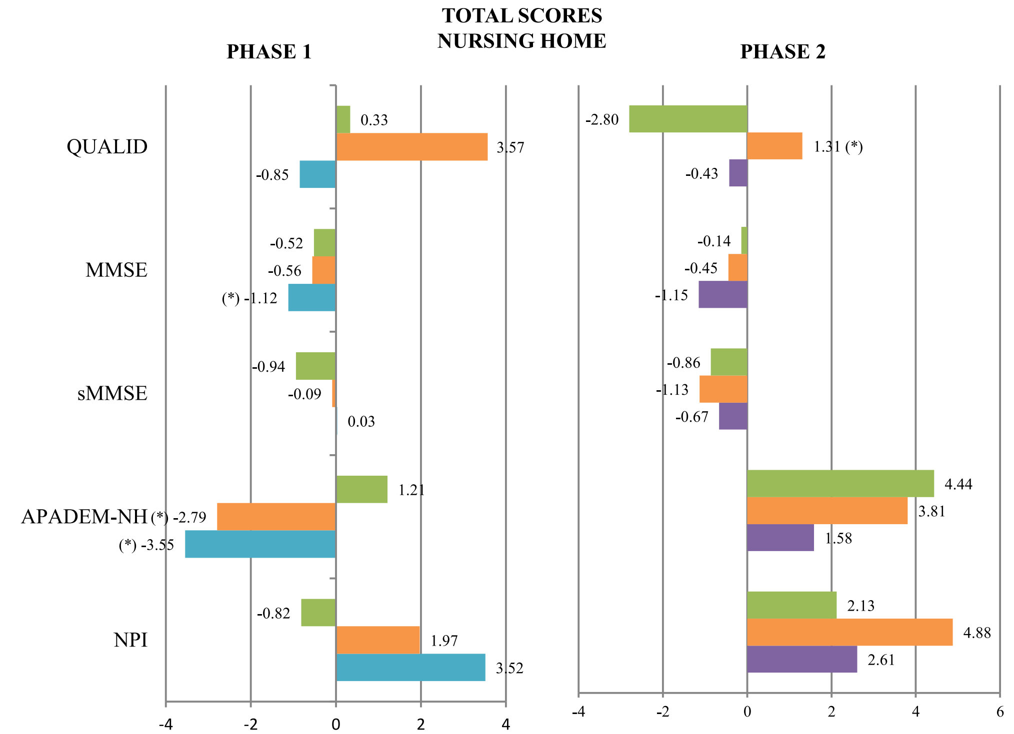

FIGURE 2 | Mean change at follow-up evaluation in the QUALID, MMSE, sMMSE, APADEM-NH, and NPI scores in the three patients groups of Phase 1 and Phase 2. CONTROL (green), PARO (orange), NAO (blue), and DOG (purple) (*): Statistically significant differences between the groups at follow-up were observed. *P* not corrected <0.05. The scales are represented on the vertical axis and the mean change in the units of measure of each scale is represented on the horizontal axis.

years old (range: 59–101 years), 90% of which were women, were included.

Dementia diagnosis was: 88.2% Alzheimer disease, 7.3% mixed dementia, 3.6% Parkinson's disease dementia, 1.8% dementia with Lewy bodies, 0.9% Frontotemporal dementia.

There were 32 people in the CONTROL group, 42 in the PARO group and 36 in the DOG group. Evaluation showed no significant differences between groups at baseline, except on the NPI irritability item (CONTROL group: 3.78 ± 3.3; PARO group: 2.14 ± 3.05; DOG group: 2.13 ± 3.28; $p = 0.0215$).

All groups showed a statistically significant increase in GDS scores, indicating a decreased functional level (Fisher's exact $<$ 0.000) at follow-up.

There were no statistically significant differences in MMSE, sMMSE, APADEM-NH, and Total NPI scores between groups at follow-up (**Figure 2**).

On the contrary, statistically significant differences were found after treatment in QUALID scores (a significant increase in the PARO group), and several NPI items: hallucinations and irritability/lability (a significant increase in the PARO and the DOG groups vs. the CONTROL group than decreases), disinhibition (a significant increase in the PARO group vs. the DOG group) and night-time behavior disturbances (a significant decrease in the PARO group vs. the DOG group) (**Figure 4** and **Table 1**).

Day Care Center

Phase 1

In phase 1, 20 patients with moderate/severe dementia, mean age 77.9 years (range: 68–87), 50% women, were included.

Dementia diagnosis was: 75% Alzheimer disease, 15% mixed dementia, 5% Parkinson's disease dementia, 5% dementia with Lewy bodies.

After the sessions with NAO, follow-up evaluation showed: an increase in GDS scores (changes from baseline to follow-up: GDS 3:15–10%; GDS 4: 5% (no change); GDS 5: 40–30%; GDS 6: 25–30%; GDS 7: 15–25%). There were no statistically significant changes in sMMSE and MMSE scores.

Significant decrease was seen in: NPI-irritability/lability scores and total NPI scores (**Figure 5** and **Table 1**).

Phase 2

In the second phase, 17 patients with moderate/ severe dementia, mean age 79 years (range: 69–87), 58.8% women, were included.

Dementia diagnosis was: 82.4% Alzheimer disease and 17.6% mixed dementia.

At follow-up, after sessions with PARO: GDS scores increased (GDS 4:5.88–0%; GDS 5: 41.18% (no change); GDS 6: 35.29–29.4%; GDS 7: 17.65–29.4%). There were no statistically significant changes in sMMSE and MMSE scores, or in any other variable (**Figure 5**).

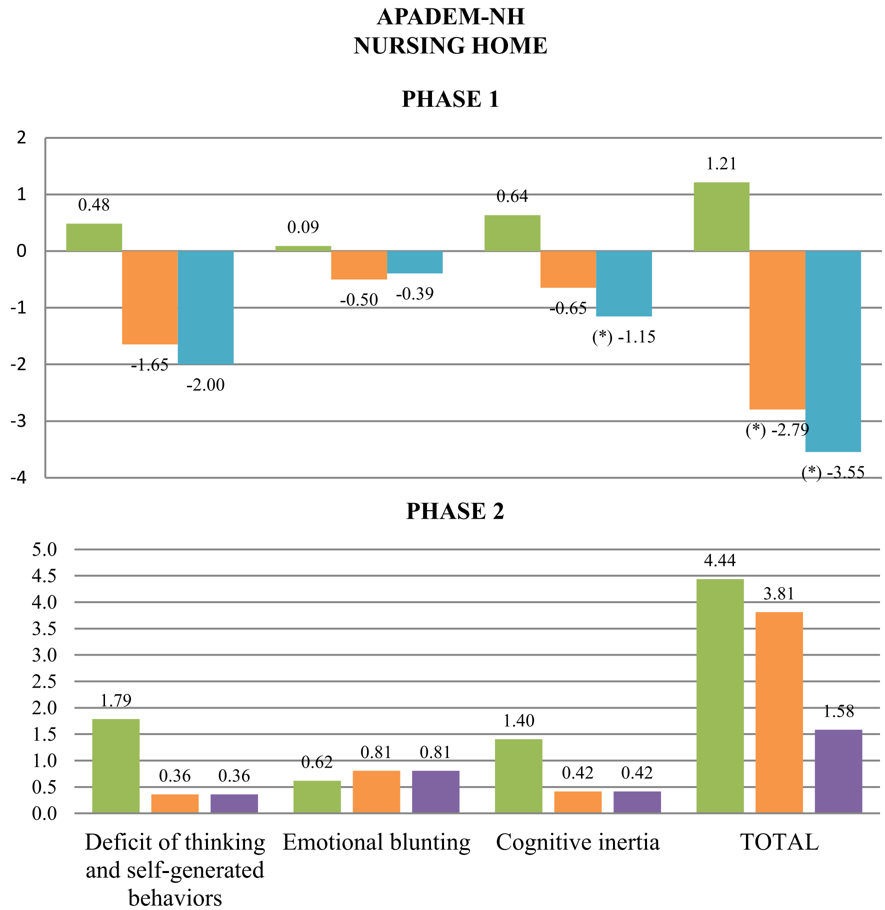

FIGURE 3 | Mean change at follow-up in APADEM-NH scores, by item and total, for the three patients groups of Phase 1 and Phase 2. CONTROL (green), PARO (orange), NAO (blue), and DOG (purple) (*): Statistically significant differences between the groups at follow-up were observed. *P* not corrected <0.05. The scales are represented on the horizontal axis and the mean change in the units of measure of each scale is represented on the vertical axis.

Discussion

To our knowledge, this is the first study, in one single center, where an animal-esque robot, a humanoid robot and trained therapy dogs were compared as potential tools for therapy for people with dementia. These new tools were the only change introduced to the patients by the intervention, because changes in personnel and environment were carefully controlled for limiting the effect of possible confounding effects.

In order to control for environmental factors, the regular therapists performed the sessions, rather than new therapists trained in the use of robots or dogs who would be unfamiliar to the patients. However, while there are therapists who specialize in animal therapy, there are currently no therapists who specialize in therapy using robots. Additionally, while the application of animal-esque robots in therapy targeted toward people with dementia has been documented, to our knowledge this is the first time that the NAO robot has been used for this purpose. Therefore, although some more training in AAT might have improved the results, it might have also introduced a bias in favor of the dog, because there is greater body of knowledge and more training materials concerning AAT than robot assisted therapy.

The measures used were internationally validated scales which have proven to be sensitive and specific measures of the target symptoms. All evaluations were performed by professionals trained in the use of the measures. The changes observed after the introduction of these new tools affected all of the investigated variables:

Quality of life (QoL), measured with the QUALID scale, was only studied in the nursing home groups. In the first phase no changes were observed, but in the second one, the group of patients who worked with the conventional therapy showed improvement, while the group who worked with the animal robot slightly worsened. In 2009 Tapus et al. proposed a customized protocol for the use of social auxiliary robots as tools to improve the QoL of people with dementia, through motivation, encouragement, and companionship for users suffering from cognitive changes related to aging and/or Alzheimer's disease (Tapus, 2009). A social robot, AIBO, was used for 7 weeks with community-residing and institutionalized

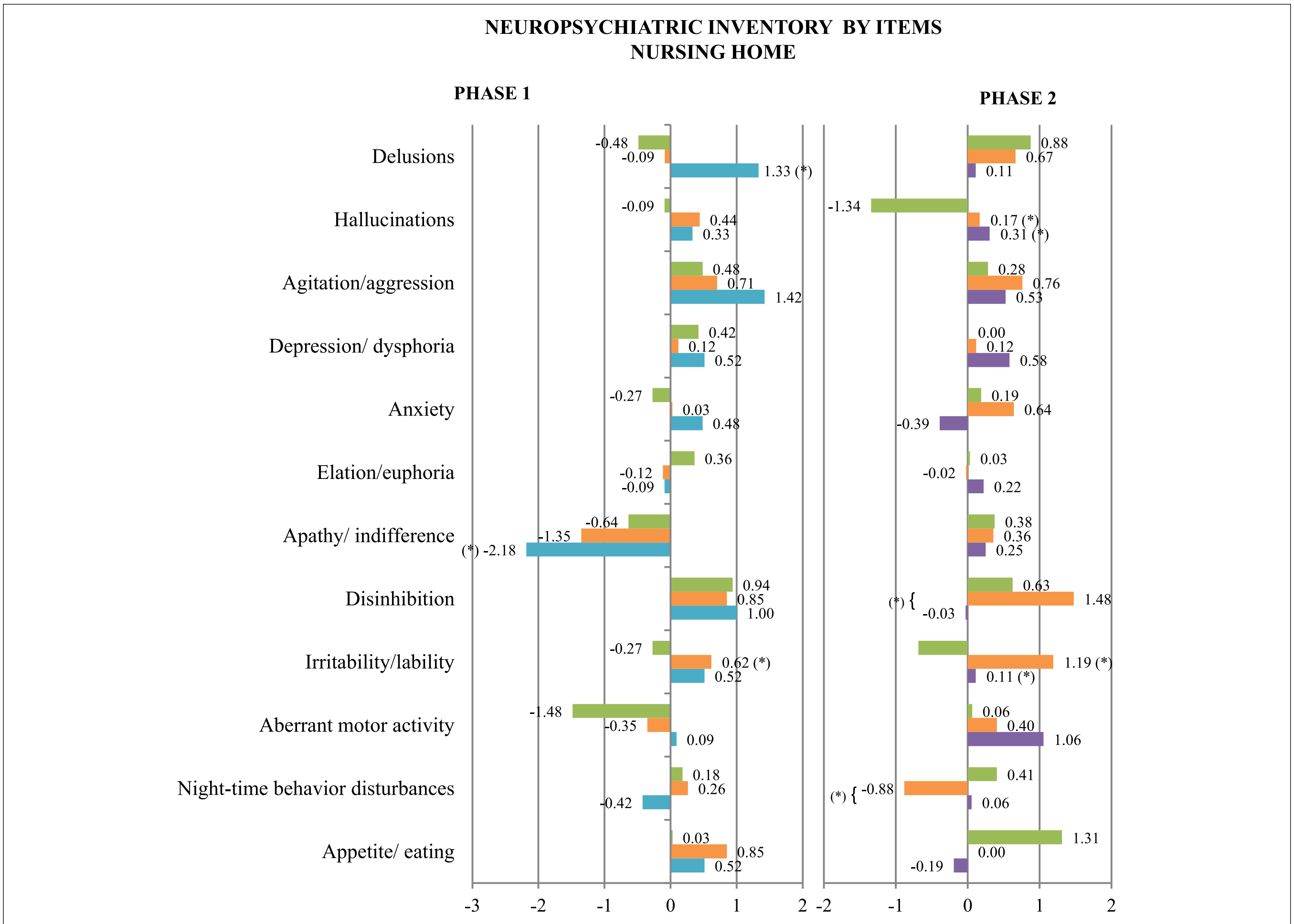

FIGURE 4 | Mean change at follow-up in NPI scores, by item, for the three patients groups of Phase 1 and Phase 2. CONTROL (green), PARO (orange), NAO (blue), and DOG (purple) (*): Statistically significant differences between the groups at follow-up were observed. *P* not corrected <0.05. The scales are represented on the vertical axis and the mean change in the units of measure of each scale is represented on the horizontal axis.

elderly and incapacitated patients. These patients showed significant improvements in QoL as measured by some health-related QoL questionnaires (Kanamori et al., 2003). In contrast, our study has barely shown significant changes in QoL, with the only change being a slight decrease in the QoL of patients in the animal robot group.

Global deterioration scale and **cognitive state** (measured with MMSE and sMMSE) worsened in all the follow-up evaluations as was expected in a progressive and degenerative disease. Only one exception was observed: after the use of NAO, in the nursing home, the sMMSE remained the same. In the same group and experiment, a significant decrease in the MMSE score was observed. Although the MMSE and the sMMSE are both screening scales for cognitive decline, the sMMSE is more appropriate for people with moderate and severe dementia, such as the people who participated in this program. A literature review found that animal-assisted interventions with elderly patients with dementia has a positive effect on communication and coping ability, but not on cognitive performance (Bernabei et al., 2013). In 2008, an improvement in dementia patients' cortical neuronal activity was observed using a 21-channel EEG after the use of PARO (Wada et al., 2008). Several studies (Tapus et al., 2009; Chan and Nejat, 2010; Fasola and Mataric, 2010) describe the use of social robots as a tool for monitoring and encouraging cognitive activities of the elderly and/or individuals suffering from dementia as improving task performance and reducing user frustration. Increased cortical neuronal activity or greater motivation to perform and complete cognitive tasks could lead to a better cognitive test outcome in social robots groups, but in this study, changes between groups were not observed.

Twelve **neuropsychiatric symptoms** were analyzed via the NPI, the APADEM-NH and the AI. **Apathy** is a prominent symptom in dementia. The APADEM-NH scale, a tool developed at the ACRSF, was used to measure apathy. The scale has the advantage of accurately measuring apathy independently of the patient's degree of dementia or depression. As the APADEM-NH is not suitable for people who are not living in a nursing home, the AI was used in the day care center. The apathy item of the NPI scale was additionally used to examine apathy. In the nursing home, in the first phase, statistically significant improvement was seen in the total scores on the APADEM-NH of patients in both robot groups, and in the scores on

TABLE 1 | Baseline and follow-up means, standard deviation (SD) and *p*-value (P) in every variable of the study with statistically significant change in the patient groups [CONTROL (C), PARO (P), NAO (N), and DOG (D)] in the nursing home and the day care center.

		Variable		CONTROL				PARO				P C-P	NAO				P C-N	P P-N
				Baseline mean	*SD*	Follow-up mean	*SD*	Baseline mean	*SD*	Follow-up mean	*SD*		Baseline mean	*SD*	Follow-up mean	*SD*		
Nursing home	Phase 1	MMSE		3.64	5.42	3.12	4.72	3.20	4.95	2.74	4.72	0.282	3.55	5.18	2.42	4.49	**0.022**	0.145
		SMMSE		8.67	10.14	7.73	9.56	7.97	8.84	8.12	9.68	0.239	7.76	8.65	7.79	9.00	0.702	0.586
		APADEM-NH	Total	43.21	21.80	44.42	23.59	48.40	19.12	44.74	22.29	**0.049**	45.06	20.69	41.52	22.59	**0.030**	0.564
			Cognitive inertia	10.73	5.89	11.36	6.32	11.97	5.27	11.15	5.79	0.251	12.03	5.48	10.88	6.30	**0.034**	0.313
		NPI	TOTAL	27.36	14.01	26.55	16.05	22.17	12.96	24.44	17.10	0.246	27.94	15.03	31.45	21.55	0.238	0.782
			Delusions	0.91	1.99	0.42	1.54	0.66	1.98	0.59	2.23	0.455	0.79	1.82	2.12	3.90	**0.011**	0.063
			Apathy/indifference	8.73	2.54	8.09	3.43	9.26	2.28	7.82	3.35	0.292	8.85	2.55	6.67	3.96	**0.047**	0.275
			Irritability/lability	2.58	2.97	2.30	3.02	1.89	2.99	2.56	3.78	**0.033**	3.21	3.66	3.73	3.67	0.085	0.728

		Variable		CONTROL				PARO				P C-P	DOG				P C-D	P P-D
				Baseline mean	*SD*	Follow-up mean	*SD*	Baseline mean	*SD*	Follow-up mean	*SD*		Baseline mean	*SD*	Follow-up mean	*SD*		
Nursing home	Phase 2	QUALID		27.70	7.82	24.72	6.68	25.44	7.56	26.75	8.16	**0.044**	24.91	7.39	24.33	6.68	0.101	0.547
		NPI	Total	26.53	20.33	28.66	19.08	24.40	16.15	29.29	19.60	0.294	19.72	15.15	22.33	14.67	0.649	0.364
			Hallucinations	1.81	3.18	0.47	1.54	0.93	2.32	1.10	1.92	**0.020**	0.17	0.74	0.47	1.21	**0.004**	0.625
			Disinhibition	0.91	2.68	1.53	3.36	0.62	1.41	2.10	3.88	0.172	0.92	2.52	0.89	2.61	0.599	**0.026**
			Irritability/lability*	3.78	3.31	3.09	4.17	2.14	3.06	3.33	4.23	**0.003**	2.14	3.29	2.25	2.93	**0.024**	0.873
			Night-time behavior disturbances	1.16	2.26	1.56	3.19	2.43	3.51	1.55	2.78	0.078	1.11	2.69	1.17	2.36	0.771	**0.028**

		Variable		NAO				P
				Baseline mean	*SD*	Follow-up mean	*SD*	
Day care C.	Phase 1	NPI	TOTAL	33.65	21.91	22.47	12.89	**0.007**
			Irritability/lability	3.25	3.41	1.57	2.67	**0.046**

**Significant differences between groups at baseline evaluation. P not corrected <0.05. Bold values are p < 0.05.*

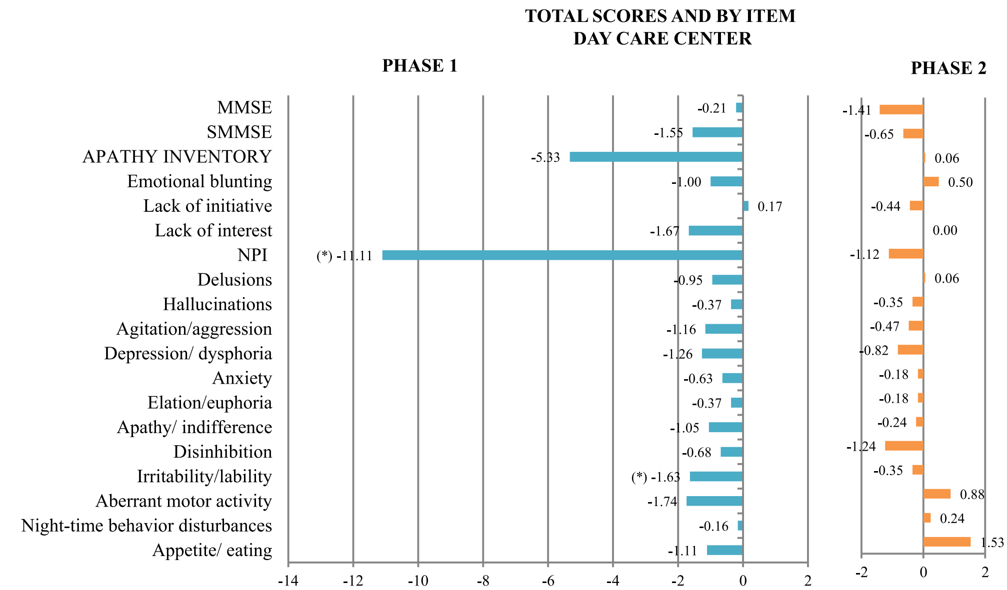

FIGURE 5 | Mean change at follow-up in scores on all the scales used, both totals and by item, in the day care center group of Phase 1, with NAO (blue), and Phase 2, with PARO (orange). (*) Statistically significant differences between the groups at follow-up were observed. *P* not corrected <0.05. The scales are represented on the vertical axis and the mean change in the units of measure of each scale is represented on the horizontal axis.

the apathy item of the NPI scale and the cognitive inertia item of the APADEM-NH of patients in the NAO group. This results replicate previous studies were, despite a lack of methodological rigor, it is apparent that non-pharmacological interventions have the potential to reduce apathy in dementia (Brodaty and Burns, 2012). In the second phase, no statistically significant difference in measures of apathy was found. An explanation could be that apathy in institutionalized patients with advanced dementia seems to increase in time (Wetzels et al., 2010) and therapeutic interventions may have a window in mild and moderate dementia, but not in advanced dementia (López and Agüera-Ortiz, 2014). In the day care center, there was no statistically significant difference in apathy.

Analysis of the NPI scores of all patients in this study reveals a random assortment of changes that were minimal at best. Statistically significant changes were observed in:

- The NAO group:
  - Impairment in delusions and
  - Improving in apathy (Phase 1 nursing home), total score and irritability/lability (day care center)
- The PARO group:
  - Impairment in irritability/lability (nursing home), hallucinations (Phase 2 nursing home) and disinhibition (vs. the DOG group)
  - Improving in night-time behavior disturbances (vs. the DOG group).
- The DOG group:
  - Impairment in hallucinations, irritability/lability

Measures of irritability on the NPI item in the nursing home groups at baseline for Phase 2 showed statistically significant differences between groups, which casts some doubt on the significance of the follow up results.

The changes observed in hallucinations and in the DOG group were produced more by the improvement in the other therapeutic groups, than by its impairment.

A decrease in agitation after the use of animal assisted interventions has been described in the literature (Churchill et al., 1999; Richeson, 2003; O'Neil et al., 2011; Bernabei et al., 2013), as a decrease in behavioral symptoms after the use of a therapy dog during the day time hours ($p < 0.05$) with no significant differences during the evening hours (McCabe et al., 2002). Behavioral improvement, as defined by a reduction in anxiety and aggressiveness, has also been previously reported after the use of PARO (Shibata and Coughlin, 2014). These previous findings were not replicated in this study.

Limitations

The study was designed in order to minimize any potential biases: 3 months of therapy were used in order to decrease the novelty effect, the raters and statistician were blinded, several recording sessions were held before the study began to get the patients and therapists used to the presence of the camera and decrease the Hawthorne effect, interaction between ACRSF regular caregivers and the robots and dogs was avoided to reduce potential informant bias, and while active participation in the therapy sessions was encouraged in order to decrease selection bias patients were not forced to interact with the therapist or the tools.

Throughout the study, several participants left the center or unit or died, and several patients joined the study late. Most of these changes did not occur during the interventions. Some participants were only evaluated once, due to hospitalization, illness or absence from the center: only 1.6% of participants were lost to follow up in the first year and 2.3% in the second.

This study was a pilot study in a sample, not representative of the general population, with a low number of participants. The changes after the use of the three new tools were minimal, and some of the statistical significant changes may be false positives, due to the high number of comparisons made and to the relatively small sample sizes. It is not possible to conclusively state that these tools were the cause of the changes seen, because of several possible confounding factors (i.e., differences in participants' pharmacologic regimens or type of dementia). However, these factors were controlled for, and will be investigated in future research.

In the nursing home, randomization was done by unit, not by individual participant. Although individual randomization would have been optimal, it would have required moving residents to different units for the sessions and would have introduced major changes in the daily routines and environments of the participants. Additionally, the environments and the characteristics of the individuals in units of the same dementia level are very similar. Baseline evaluation showed no difference between any of the nursing home groups on any of the measures (except in irritability in the nursing home in Phase 2), indicating that there is no significant difference between people who live in different units in the variables analyzed in this study.

Concluding Remarks

In a controlled pilot study of parallel groups in institutionalized patients with moderate/severe dementia comparing 3 months of assisted therapy with:

- A humanoid robot, an animal-shaped robot and conventional therapy, the main findings were: a decrease in apathy in the humanoid and animal shaped robot groups; increased delusions in the group treated with the humanoid robot and increased irritability in both robot groups; and a decrease in scores on the MMSE, but not the sMMSE, in the humanoid robot group. There were no statistically significant differences between the humanoid and animal shaped robot groups.
- An animal-shaped robot, a real therapy dog and conventional therapy, the main findings were: a decrease in quality of life in the animal shaped robot group compared to the conventional therapy group; increased hallucinations and irritability in both the robot and animal groups compared to the control group; increased disinhibition in the animal-shaped robot group and decreased disinhibition in the humanoid robot group, decreased night-time behavior disturbances in the animal-shaped robot group and increased night-time behavior disturbances in the dog group.

In a study of robot therapy sessions for patients with moderate/severe dementia cared for at a day care center, participants showed improvements in irritability and global neuropsychiatric symptoms after participating in sessions with the humanoid robot, but not after sessions with the animal-shaped robot.

Future Studies

Randomized controlled trials are needed with a larger amount of patients, in order to better understand the effects of robots and dogs on the therapy of people with dementia.

Additionally, new scales that are internationally validated and more sensitive and specific are needed, in order to detect the slight changes in behavior, emotion and cognition that were observed during the session but were not significant enough to appear in the analysis.

As a result of this study, our team is going to focus on the use of humanoid robots in cognitive therapy for people with mild dementia and in the use of pet robots for people with moderate to severe dementia.

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Robotherapy with dementia patients

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Abstract Humanoids have increasingly become the focus of attention in robotics research in recent years, especially in service and personal assistance robotics. This paper presents the application developed for humanoid robots in the therapy of dementia patients as a cognitive stimulation tool. The behaviour of the robot during the therapy sessions is visually programmed in a session script that allows music to play, physical movements (dancing, exercises, etc.), speech synthesis and interaction with the human monitor. The application includes the control software on board the robot and some tools like the visual script generator or a monitor to supervise the robot behaviour during the sessions. The robot application's impact on the patient's health has been studied. Experiments with real patients have been performed in collaboration with a centre of research in neurodegenerative diseases. Initial results show a slight or mild improvement in neuropsychiatric symptoms over other traditional therapy methods.

Keywords Social Robotics, Humanoid robot, Robot Therapy

1. Introduction

One field of growing interest in robotics is humanoids. Prototypes such as the Honda Asimo or the Fujitsu HOAP-3 are the basis for many research efforts, some of them designed to replicate human intelligence and manoeuvrability. Their appearance, being similar to people, facilitates their acceptance and natural interaction with humans as a personal assistant in, for instance, the field of service robotics. As a representative sample, the functionality achieved in the Asimo humanoid has progressed significantly in recent years, allowing it to run, climb stairs, push carts and serve drinks.

Neurodegenerative dementia is a disease that progressively deteriorates brain functionality. One of the most common symptoms of dementia is memory loss. In addition, patients usually lose the ability to solve problems or control their emotions and present changes in personality and normal behaviour. Over time, people with dementia are unable to properly perform the basic activities of daily living such as maintaining personal hygiene or food. Estimates point to the fact that by 2016 there will be 26.6 million people worldwide with Alzheimer's disease, and this figure will be three times bigger by 2050 when Alzheimer's will affect 1 in 85 people of the total world population. In addition, 40% of them will be in an advanced state of disease, requiring a level of care that involves high consumption of resources [1].

While there is no causal cure for the disease, palliative medication and nonpharmacological therapy are the only ways patients can improve symptoms and slow down its progression.

Nonpharmacological therapy focuses on strengthening activities mentally, physically and emotionally. Such actions seek to maintain the functional capacity of the person, while ensuring her levels of quality of life and autonomy. Animal therapy has also shown good results, especially with the elderly living alone. However, this is not always possible as sometimes the entrance of animals into residences for the elderly is not allowed for health and safety reasons. Other times it is the cost of maintaining these animals and the care they need which precludes their presence in the residence. Another issue to consider is that the therapeutic interaction at the cognitive level needed in older people with dementia is not resolved with the presence of animals in the patient's environment [2].

Regular therapy includes several sessions per week with a human therapist monitoring a group of patients. The therapist asks patients simple questions, tells them stories, talks to them, interacts with them, hugs them, suggests games, riddles or guides them while doing physical exercises. These activities pursue the cognitive, affective and physical stimulation of the patients.

In this paper we describe the use of a humanoid robot as a cognitive stimulation tool in the therapy of dementia patients. Several software modules have been programmed to generate the robot behaviour in the therapy sessions. Three types of robotherapy sessions have been developed: physiotherapy,

music and logic- language sessions. The robot and the developed software have been used in a pilot study with real patients to evaluate the feasibility and usefulness of robots in dementia therapy.
The remainder of this paper is organized as follows. The second section presents some works with social robots and their use in dementia therapies. The third section explains all the software developed for this humanoid application, including some tools designed to visually program the robot behaviour for the robotherapy sessions. The fourth section describes the experiment performed with real patients to measure the impact of this robotic tool on their health and some preliminary results are presented. Finally, some conclusions are summarized.

2. Related Works

Interest in social robots is growing as one of the upcoming application fields of next generation robots, for instance, gaming platforms [3], personal assistants, nursing robots [4] or assistive tools in rehabilitation [5].
In the past five years, several projects have been initiated with the therapeutic use of social robots [6] as reasonable substitutes for animal therapy in people with dementia. Robots do not involve the responsibility or the need for an animal facility and their sensors can respond to environmental changes (movements, sounds, etc.) simulating an interaction with the patient [7]. At the same time, they provide the opportunity to monitor patients and perform cognitive therapy, unlike animal therapy [8]. Other potential benefits of therapy with robots are that it has no secondary effects (like drug therapy) and does not require specially trained personnel (as opposed to the other therapies such as music therapy, pet therapy, etc.).
The seal-shaped Paro robot has been used in dementia therapies [9] with positive results.
Broekens et al. published in 2009 [10] a systematic review analysing the literature on the effects of social robots in the health care of the elderly, especially in the role of company for the patient. It is noteworthy that all studies were undertaken after 2000, indicating the novelty of this research area. Most studies have been conducted in Japan, Southeast Asia and the U.S. [11]. The main results of analysis of these studies are:
· Most of the elderly like robots.
· The shape and material of the robot influence the acceptance and the effect of the robots.
· Improved health by lowering stress levels (measuring stress hormones in urine) [12] and increased immune system response [13].
· Improvement of humour (through surveys and the evaluation of facial expressions).
· Decreased sense of loneliness (using scales measuring loneliness).
· Increased communication (measured by the frequency of contact with robots and family).
· Remembering the past (especially with a robot shaped as a baby).
· Some studies indicate that the use of robots helps to reduce the severity of dementia in some patients.

3. Robot software for robotherapy

We created a programming framework, named Behaviour-based Iterative Component Architecture (BICA) [14], to develop autonomous applications for our humanoid robots. It has been used in research for several years around the RoboCup environment, in teaching at robotic courses at Universidad Rey Juan Carlos and it has also been used for robotherapy.
We have developed several software pieces for the use of humanoids in therapy. The robot behaviours in therapy sessions are described mostly as a sequence of basic movements, music or text playing and light turning on-off operations. File format syntax has been developed to store these behaviour descriptions - they are called session scripts.
Some specific components inside BICA have been developed, like one that runs session scripts or another that provides access to robot lights from the application software. In addition, some tools have also been created: a session script generator that allows easy and visual “programming” of robot behaviour in therapy sessions, and the session monitor tool that helps the human therapist to control the session progress. They are all described in this section.

3.1 BICA Architecture

The software of our humanoid robot is organized with a behaviour-based architecture. It is implemented in component-oriented software architecture, BICA, programmed in C++ language. Components are independent computation units which periodically execute control iterations at a pre-configured frequency.

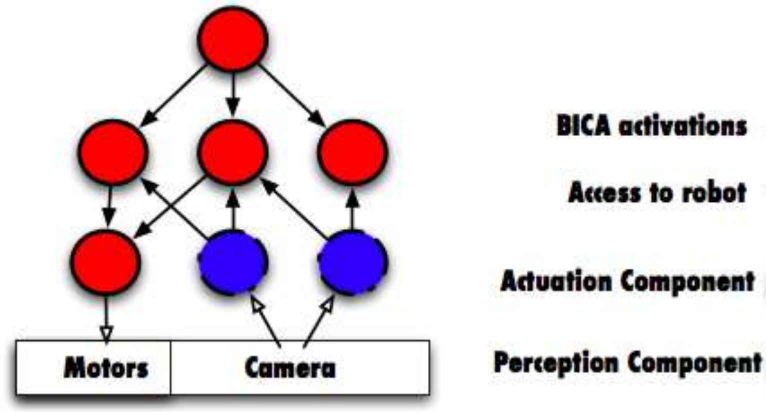

Figure 1. Behaviour in BICA composed by actuation and perception components

Every component has an interface to modulate its execution and to retrieve the results of its computations.
Behaviours in BICA are defined by the activation of perception components and actuation components. Actuation components take movement decisions, send commands to the robot motors, or locomotion system, or activate other actuation components. They run iteratively to periodically update their outputs. Perception components take data from the robot sensors or other perception components and extract information. They basically provide information to the actuation components. The output of a perception component is refreshed periodically and can be read from many other components in the system.
Not all the perception capabilities of the robot must be active at the same time, consuming computing resources. Even more, the whole set of behaviours that the robot is able to perform is not suitable for dealing with the current situation. Only a subset of those behaviours and perception units are relevant to the current

situation. In BICA, each component can be activated and deactivated at will, so it remains inactive until the situation demands it - when another component activates it. Typically an actuation component activates the perception components it requires and activates the child actuation components (if any) that implement its control decisions. This activation chain creates a dynamic component tree to cope with the robot's current situation. Figure 1 shows a component activation tree with both perception and actuation components.

Beyond being a framework to integrate perceptive and actuation capabilities for autonomous behaviours, the BICA architecture also includes components that provide access to the basic sensors and actuators of the robot, a Hardware Abstraction Layer (HAL) for robot applications. BICA is built on top of Naoqi, the manufacturer middleware, and offers this HAL as a set of object method invocations. For instance, the Body component provides access to the motion capabilities, both the legged locomotion and the arm movements. The Perception component provides access to the camera images. The LED component provides access to several lights on the robot head and chest, which can be turned on and off from the application software. The Head component provides access to the neck of the humanoid, allowing the head to be rotated horizontally or vertically. The Music component provides the capability of playing sound files which has been specifically developed for the robotherapy application. The stories, questions, songs involved in therapy sessions are stored as sound files and played back using this BICA component.

The behaviour-based organization of the software of the robot in BICA allows a modular development of robot functionalities, with new components to accomplish new robot tasks or to perceive new associated stimuli.

Beyond the humanoid behaviour in the robotheraphy application, this architecture has also been used for the programming of humanoid behaviours in other scenarios like the RoboCup competition. We have developed several perceptive and actuation components for the robot soccer player inside the RoboCup Standard Platform League. Some actuation components were programmed as PID reactive controllers and others as Finite State Machines, depending on the complexity of the behaviour.

3.2 Session script generator

The robot behaviour set required for robotherapy application is smaller than for other fully autonomous applications like the robotic soccer in RoboCup. In essence, the robot behaviours in therapy sessions are described mostly as a sequence of basic movements, music or text playing and light turning on-off operations. They are usually launched together as the robot may be, for instance, playing a song and dancing at the same time.

A high level language has been developed to store these behaviour descriptions. They can be stored in text files following a given syntax and read from them - they are called session scripts. The language includes three basic instructions: move, music and light. Two or three basic operations of different type can be grouped together, in group instructions, to be executed simultaneously. The robot behaviour is a sequence of these basic or group instructions. In the script some synchronization points can be included to wait for the termination of all the basic

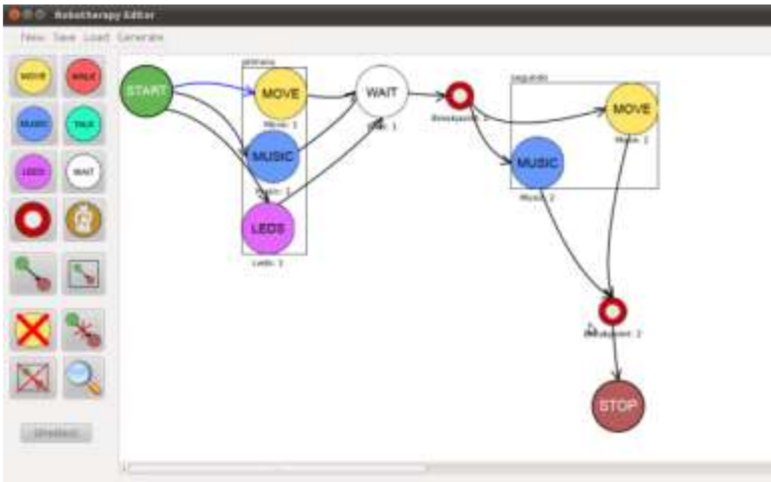

Figure 2. Session script generator

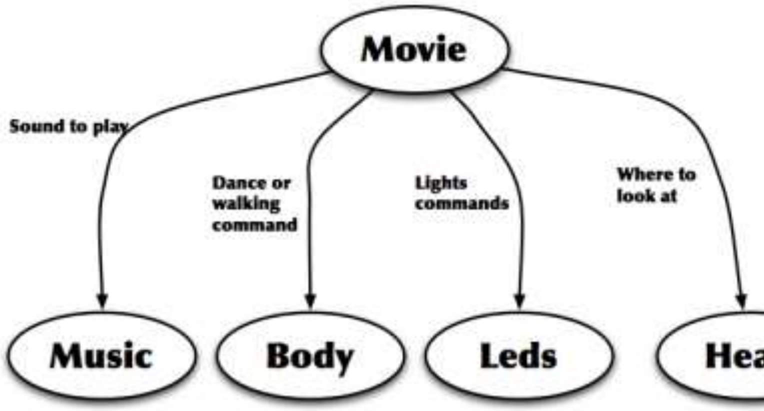

Figure 3. Movie component in BICA runs session scripts on board the robot

instructions inside a group. In addition, the wait instruction causes the robot to stop execution until the human therapist provides the continue order, striking one button on the robot body or by using any monitoring tool. This allows the human therapist to control the session progress.

The scripts are generated and stored in text files. Their contents are designed by medical doctors and health assistants, attending to the desired stimulation in the dementiar's patients. At the beginning they were created by directly editing text files, however more recently we have developed a graphical tool, the session script generator (Figure 2), that allows a fast and visual creation of these scripts.

3.3 Movie component

One specific component has been developed inside BICA for the robotherapy application, the Movie component. It accepts session scripts as input and runs the corresponding orders to robot motors and actuators, at the proper timing, unfolding the specified robot behaviour. It uses several HAL components available in BICA, like the Body, LED, Music and Head components, as shown in Figure 3.

For dancing the robot has previous descriptions of its movements. They are stored as single files following a given syntax, and they can be referenced in the scripts run by the Movie component. Those movement files include the position of all robot joints and the right time for each one. For singing or story telling the corresponding song and text are stored as sound files, and they can also be referenced in the session script.

3.4 Session monitor

The therapist needs a way to communicate with the robot, for instance, to start a robotherapy session, to stop its execution while the patients answer one of the robot questions, to repeat any script step, among other tasks. The basic interface with the real robot was the set of buttons on its feet and chest. At the beginning these buttons were used, but we developed two session monitor applications to allow an easier way to control the robot.

Figure 4. Session monitor at a regular computer

The first session monitor is an application running on a regular computer. It offers a Graphical User Interface with sliders, selectors, visual buttons, etc., as shown in Figure 4. This allows the teleoperation of the robot body and head, so that the robot can approach the patients at the beginning of the sessions, for instance. It can be operated from an external computer or used in conjunction with a Wiimote. This Wiimote device is more convenient than the regular screen, keyboard and mouse configuration. In this case the session monitor reads the therapist's orders from the Wiimote buttons and accelerometers using Bluetooth.

In order to improve the tool usability, a second session monitor has been created that runs on mobile devices like Android tablets or smartphones (Figure 5). In using this neither an extra computer nor Wiimote is required, just the

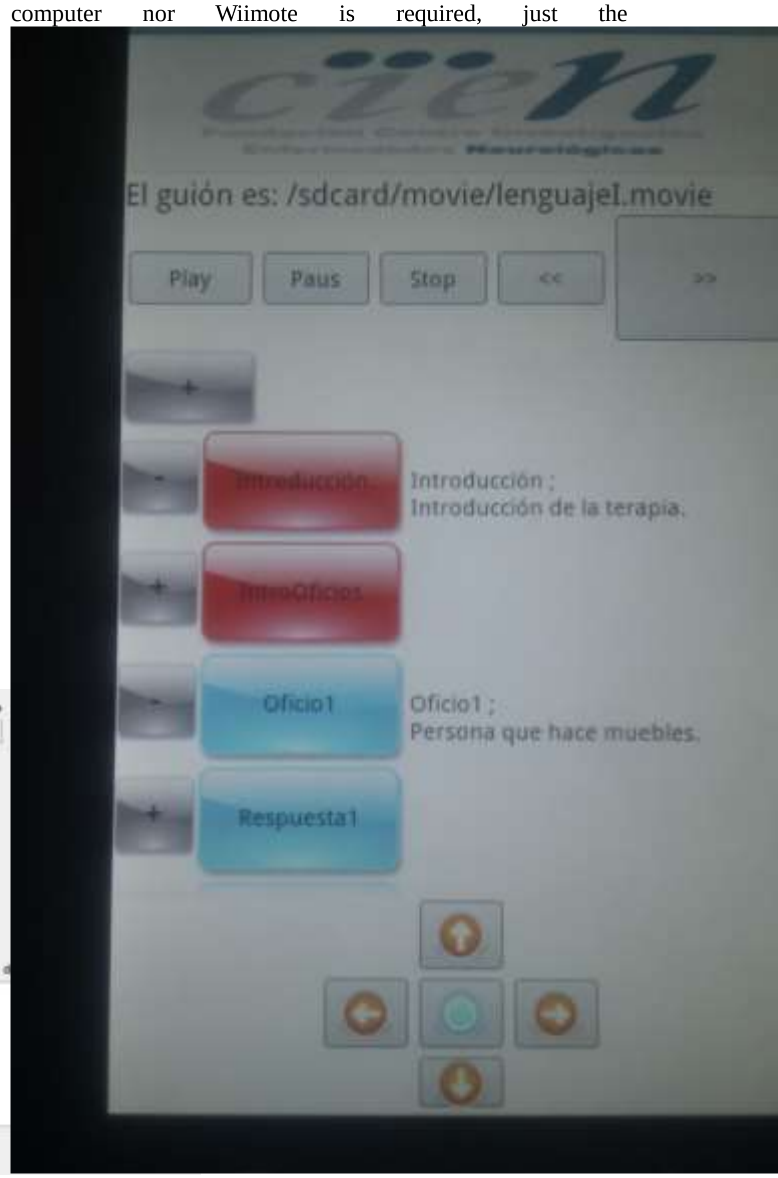

Figure 5. Session monitor at a tablet

robot and the tablet or smartphone. With this monitor, the human therapist has full control of the progress of the therapeutic session.

Interaction between different BICA components is performed as a method of invocation of other component objects. A specific module has been developed for communication between BICA and the software outside the robot, for instance, the communication between these session monitor tools and the Movie component on board the robot. This module and the session monitor use ICE as communication middleware.

4. Experiments

The platforms available for this project were initially three: the robot seal Paro, the Aibo robot dog and the Nao humanoid. One of them needed to be selected for the real experiments.
The mobility of the robot seal Paro is mainly confined to its head (its eyes move). It also produces sounds that simulate those of a baby seal.
The robot dog Aibo and the Nao humanoid offer much more functionality: they are both also nice to look at, they walk, move their head, have lights and make sounds. The larger size of humanoid makes it more visible than the robot dog. In addition, the humanoid robot is most useful in physical therapy, as it can perform physical exercises that can be directly mimicked by patients. This is a key issue.
From a technical point of view, the development of software for the robot seal Paro is complicated because it is a closed platform. Our group has extensive experience in the programming of the other two platforms in the RoboCup environment. One difference in favour of the humanoid robot Nao is the availability. Although we have several Aibo robots and it was a bestselling commercial robot, since 2008 its manufacturing has been discontinued. Currently our group is participating in the RoboCup with the Nao humanoid, and the software architecture developed to control the robot in this environment, BICA, is general enough to host the robot software for the robotherapy application.

Figure 6. Aibo robot acceptance test with dementia patients

The Aibo and humanoid robots were tested with real patients to see their acceptance (Figure 6). The Nao robot was presented to a group of 20 patients with differing severity of dementia. The humanoid robot was accepted by most of them: 80% showed a very positive attitude, 15% did not react and 5% (one person) showed aggression towards the robot (and also to therapists and psychologists). Most patients identified him as a child and tried to talk to him.
For all these reasons, the Nao humanoid was the selected platform. Nao robot is a fully programmable humanoid robot. It is equipped with a x86 AMD Geode 500 MHz CPU, 1 GB flash memory, 256 MB SDRAM, two speakers, two cameras (non-stereo), Wi-Fi connectivity and Ethernet port. It has 25 degrees of freedom. The operating system is Linux 2.6 with some real-time patches. The robot is equipped with an ARM 7 micro-controller allocated in its chest to control the robot's motors and sensors, called DCM.

4.1 Therapy sessions

The therapy session contents have been designed by therapists specialized in the disease of dementia. The robotics work focused on developing the software required so that these sessions can be carried out with maximum similarity to how they were conceived. We developed all the required software components, sounds and robot movements, and proposed new tools to be used and evaluated.

We performed cognitive therapy and physiotherapy sessions, 2 days/week during one month with a humanoid robot in a group of 13 patients (Figure 7). Evaluation at baseline and follow-up was carried out with scales to detect apathy, quality of life and dementia severity. Most of the patients had moderate-severe dementia (Figure 8), mean age 83.2 years (range: 74-91) and 92% were women.

Figure 7. Real session with dementia patients using a humanoid robot

Each session took between 30 and 45 minutes, and was recorded by two cameras. We designed four types of sessions: language, music therapy, storytelling and physiotherapy. Cognitive therapy included music therapy, playing activities and language sessions. In the language sessions the robot asked about numbers, days of the week and set riddles and questions aimed at cognitive activation. In the music therapy sessions the robot combined basic questions related to popular songs. Physiotherapy sessions consisted of a set of exercises that the robot explained and performed: movements of arms, head, torso and walking exercises. In storytelling sessions the robot told a story, moving itself and turning its lights on at the same time, there was no direct interaction with patients.

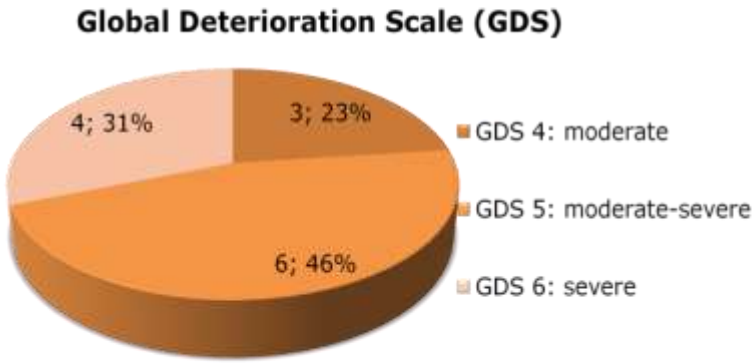

Figure 8. Global deterioration scale of the group involved in the first phase

The sessions for patients with severe dementia cannot be structured as those for people with moderate dementia because they are unable to maintain attention long enough to be effective. For them we designed a set of activities to be carried out by the robot: walking towards a patient, "looking at" her face, making sounds of animals, etc. - these actions seemed to improve their apathy. Some of these activities (walking towards a patient and "looking at" her face) were also applied during the sessions with the rest of the group, also improving their responses. To carry out these activities, we extended the software and robotic tools to be easily managed by the therapists. The Wiimote extension of the session monitor and the tablet-based session monitor has been developed after observing in the experiments the autonomy needs of the therapists.

Some preliminary medical results have been presented in medical forums and are better explained in [15]. All scales showed a trend to improvement in neuropsychiatric symptoms, apathy and quality of life, although Wilcoxon test showed no significant statistical differences between baseline and follow-up. Patients accepted well the robot and participate as actively in therapy sessions with robot as in the regular sessions.

This pilot study showed that a clinical study using robots for cognitive therapy in dementia institutionalized patients is possible. Currently we are using robots as a new tool for dementia therapists in a pilot clinical assay to discover the effect of this new non pharmacological treatment compared to habitual treatment. We involve more than a hundred patients, use a control group to compare and the evaluators are blind to the therapy.

5. Conclusions

In this paper we have presented a cutting edge application of humanoid robots in the therapy of dementia patients.

We have developed several software pieces to support this application. First, our BICA software architecture integrates all robot perceptive and actuation capabilities. Second, a software module helps to visually generate "session scripts". These session scripts are simple descriptions of robot behaviour

ıe therapeutic sessions. They involve music s and light generation capabilities onboard / have been created with the knowledge and experts, and are stored in single files. Third, inside BICA runs the session scripts on the ı monitor module allows the human therapist ·ipt execution, proceeding with the next g steps, etc., and so modulating the session different monitors have been developed, one r PC and another one running on an Android e device support has also been incorporated ontrol by the therapists, improving their

sions have been prepared and performed: therapy, physiotherapy and logic-language therapy. In music sessions, the robot plays songs from the years when the patients were young, trying to stimulate their emotions. In physiotherapy sessions, the robot performs several physical exercises with the intention of being repeated by the patients. Logic-language therapy is based on several simple questions to cognitively stimulate the patient responses.

The preliminary medical results on real patients with moderate dementia are promising. Their neuropsychiatric symptoms tend to improve over those of patients following classic therapy methods, but further research is required. Surprisingly the robot captures the attention of the elderly due to its human shape, its movements and music capabilities.

We are working on extending the direct interaction between the patients and the humanoid robot. For instance, the real patient showing coloured cards to answer questions set by the humanoid. Also we are programming the robot with more autonomous behaviours like face tracking or people following.

6. Acknowledgments

This work was supported by the project S2009/DPI- 1559, RoboCity2030-II, from the Comunidad de Madrid, by the project PI10/02567 from the Spanish Ministry of Science and Innovation and project 231/2011 from IMSERSO. The authors also want to acknowledge the collaboration of the patients, their relatives, the therapists and evaluators, in particular Luis I. Casanova, Sara Saiz, Cynthia Prez, Emma Osa, Elena Ortega, Ana Casarrubio, Cristina Martín and people from the UMA group.

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Robots in therapy for dementia patients

Francisco Martín, Carlos Agüero, José M. Cañas, Gonzalo Abella, Raúl Benítez, Sergio Rivero, Meritxell Valenti and Pablo Martínez-Martín

***Abstract*—This paper presents the application developed for humanoid robots which are used in therapy of dementia patients, as a cognitive stimulation tool. It has been created using BICA, a component oriented framework for programming robot applications, which is also described. The developed robotherapy application includes the control software onboard the robot and some tools like the visual script generator or several monitoring tools to supervise the robot behavior along the sessions. The behavior of the robot along the therapy sessions is visually programmed in a session script that allows music playing, physical movements (dancing, exercises...), speech synthesis and interaction with the human monitor. The monitoring tools allow the therapist interaction with the robot through its buttons, a tablet or a Wiimote device. Experiments with real dementia patients have been performed in collaboration with a centre of research in neurological diseases. Initial results show a slight (or mild) improvement in neuropsychiatric symptoms over other traditional therapy methods.**

***Index Terms*—Social Robotics, Humanoid robot, Robot Therapy**

I. INTRODUCTION

ONE field of growing interest in robotics are humanoids. Prototypes such as the Honda Asimo or the Fujitsu HOAP-3 are the basis for many research efforts, some of them designed to replicate human intelligence and maneuverability. Their appearance similar to people facilitates their acceptance and natural interaction with humans as a personal assistant in the field of service robotics, for instance. As a representative sample, the functionality achieved in the Asimo humanoid has progressed significantly in recent years, allowing it to run, climb stairs, push carts and serve drinks.

On other hand, neurodegenerative dementia is a disease that progressively deteriorates brain functionality. One of the most common symptoms of dementia is memory loss. In addition, patients usually lose the ability to solve problems or control their emotions and present changes in personality and normal behavior. Over time, people with dementia are unable to properly perform the basic activities of daily living such as maintaining personal hygiene or food. One type of dementia is the Alzheimer disease. Estimates pointed that in 2006 there would be 26.6 million people worldwide with Alzheimer's disease, and this figure will be three times bigger by 2050. On that date, the Alzheimer will affect 1 in 85 people of the total world population. And 40% of them will be in an advanced state of disease, requiring a level of care that involves high consumption of resources [1].

While there is no causal cure for the disease, palliative medication and nonpharmacological therapy are the only ways patients can improve symptoms and slow down its progression.

Nonpharmacological therapy focuses on strengthening the activities mentally, physically and emotionally. Such actions seek to maintain the functional capacity of the person, while ensuring her levels of quality of life and autonomy. Animal therapy has also shown good results, especially with elderly that live alone. However, it is not always possible. Sometimes the entrance of animals in elder residences it is not allowed due to health and safety reasons. Other times it is the cost of maintaining these animals and the care they need which precludes their presence in the residence. Another issue to consider is that the therapeutic interaction at the cognitive level needed in older people with dementia is not resolved with the presence of animals in the environment of the patient [2].

Regular therapy includes several sessions per week with a human therapist monitoring a group patients. The therapist asks them simple questions, tells them stories, talks to them, interacts with them, hugs them, suggests games, riddles or guides them while doing physical exercises. These activities pursue the cognitive, affective and physical stimulation of the patients.

In this paper we describe the use of a humanoid robot as a cognitive stimulation tool in therapy of dementia patients. Several software modules have been programmed to generate the robot behavior in the therapy sessions. Three types of robotherapy sessions have been developed: physiotherapy, music and logic-language sessions. The robot and the developed software have been used in a pilot study with real patients to evaluate the feasibility and usefulness of robots in dementia therapy.

The remainder of this paper is organized as follows. Second section presents some works with social robots and their use in dementia therapies. Third section explains all the software developed for this humanoid application, including some tools designed to visually program the robot behavior for the robotherapy sessions. The fourth section describes the experiment performed with real patients to measure the impact of this robotic tool on their health and some preliminary results are presented. Finally, some conclusions are summarized.

II. RELATED WORKS

The interest in social robots is growing, as one of upcoming application fields of the next generation robots. For instance

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as game platforms [3], personal assistants, nursing robots [4], assistive or rehabilitation robots [5]. In particular, assistive robots, both as mobility aids or manipulation aids, and rehabilitation robots have gained attention in the research community. The International Conference on Rehabilitation Robotics and some special issues in robotics journals (like 2003 special issue on Rehabilitation Robotics in Autonomous Robots, the 2009 one in IEEE Transactions on Robotics and the 2012 special issue on Assistive and Rehabilitation Robotics in the Journal of Behavioral Robotics) are good samples of the growing interest in this research area.

In the past 5 years, several projects have been initiated with the therapeutic use of social robots [6] as reasonable substitutes for animal therapy in people with dementia. Robots do not involve the responsibility or the need for an animal facility and their sensors can respond to environmental changes (movements, sounds ...) simulating an interaction with the patient [7]. At the same time, they provide the opportunity to monitor patients and perform cognitive therapy, unlike animal therapy [8]. Other potential benefits of therapy with robots are that it has no secondary effects (like drug therapy) and does not require specially trained personnel (as opposed to the other therapies such as music therapy, pet therapy, etc..).

The Paro robot, which has seal shape, has been used in dementia therapies [9] with positive results.

Broekens et al published in 2009 [10] a systematic review analyzing the literature on the effects of social robots in the health care of the elderly, especially in the role of the company to the patient. It is noteworthy that all studies are after 2000, which indicates the novelty of this research area. Most studies have been conducted in Japan, Southeast Asia and the U.S. [11]. The main results of analysis of these studies are:

- Most of the elderly like robots.
- The shape and material of the robot influence the acceptance and the effect of the robots.
- Improving health by lowering stress levels (measuring stress hormones in urine) [12] and increased immune system response [13].
- Improvement of humor (through surveys and the evaluation of facial expressions)
- Decreased sense of loneliness (using scales measuring loneliness)
- Increased communication (measured by the frequency of contact with robots and family).
- Remember the past (especially with a robot as a baby).
- Some studies indicate that the use of robots helps to reduce the severity of dementia in some patients.

III. BICA SOFTWARE ARCHITECTURE FOR ROBOT CONTROL

We have used the Nao humanoid robot in the therapy of dementia patients. This robot is sold with a programming environment, named Naoqi, of the manufacturer to develop applications in C++ and Python. Naoqi is a distributed object framework which allows to several distributed binaries be executed, all containing several software modules which communicate among them. Robot functionality is encapsulated in software modules. In order to access sensors and actuators we have to communicate with specific modules like ALMotion or ALVideoDevice module.

Naoqi is voracious, its communication and synchronization mechanisms consume a lot of memory and computing resources, which can affect the robot movements. It is possible to develop basic robot behaviors using only the Naoqi framework, but it is not enough for our needs and the development of complex applications using NaoQi alone is hard. We preferred an architecture that lets us activate and deactivate components, which is more related to the cognitive organization of a behavior based system. That is why we have created a programming framework, named Behavior-based Iterative Component Architecture (BICA) [14], on top of Naoqi (Figure 1), to develop autonomous applications for our humanoid robots. BICA has been used for several years in teaching robotic courses at Universidad Rey Juan Carlos, in research around the RoboCup environment, and it has also been used for robotherapy. BICA uses Naoqi mainly as a driver to access to robot sensors and actuators.

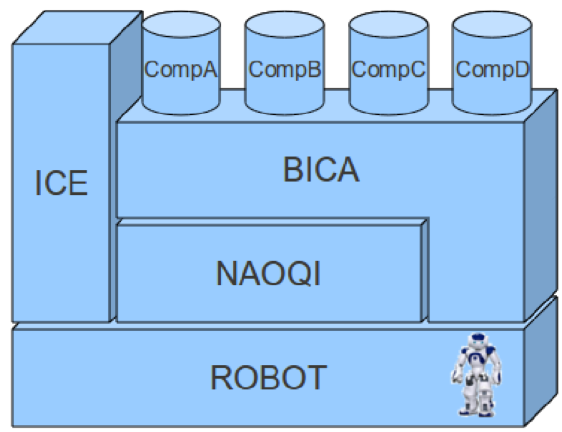

Fig. 1. BICA programming environment

A. BICA core and components

The software of our humanoid robot is organized with a behavior-based architecture. It is implemented in a component oriented software architecture, BICA, programmed in C++ language. Components (like CompA, CompB, etc. in Figure 1) are independent computation units which periodically execute control iterations at a pre-configured frequency. Every component has an interface to modulate its execution and to retrieve the results of its computations.

We have implemented our BICA architecture in a single Naoqi module. The components are implemented as Singleton C++ clases and they communicate among them by method calls (faster than SOAP Naoqi message passing). Each component has a `step()` method to run once its control (or processing) iteration, this method is periodically called from the timing motor of BICA (further details in [14]). Additionally, the components may include some methods to provide the results of its processing or to receive modulation from others.

The robot applications are organized as a collection of connected components, perceptive ones and actuation ones. Behaviors in BICA are defined by the activation of perception components and actuation components. Actuation components take movement decisions, send commands to the robot motors, or locomotion system, or activate other actuation components. They run iteratively to periodically update their outputs. Perception components take data from robot sensors or other perception components and extract information. They basically provide information to the actuation components. The output of a perception component is refreshed periodically and can be read from many other components in the system.

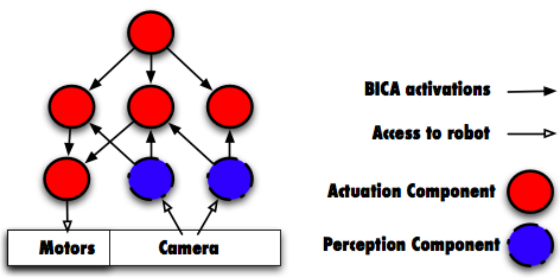

Fig. 2. Behavior in BICA composed by actuation and perception components

Not all the perception capabilities of the robot must be active at the same time, consuming computing resources. Even more, the whole set of behaviors that the robot is able to eventually perform is not suitable to deal with the current situation. Typically only a subset of available behaviors and perception units are relevant to the current situation. In BICA each component is activable and deactivable at will, so it remains inactive until the situation demands it, when another component activates it. Usually an actuation component activates the perception components it requires and the child actuation components (if any) that implement its control decisions. This activation chain creates a dynamic component tree to cope with the robot's current situation. Figure 2 shows an component activation tree with both perception and actuation components.

Beyond being a framework to integrate perceptive and actuation capabilities for autonomous behaviors, the BICA architecture also includes components that provide access to the basic sensors and actuators of the robot, a Hardware Abstraction Layer (HAL) for robot applications. BICA is built on top of Naoqi, the manufacturer middleware, and offers this HAL as a set of object method invocations. For instance, the `Body` component provides access to the motion capabilities, both the legged locomotion and the arm movements. The `Perception` component provides access to the camera images. The `LED` component provides access to several lights on the robot head and chest, which can be turned on and off from the application software. The `Head` component provides access to the neck of the humanoid, allowing to rotate the head horizontally or vertically. The `Music` component provides the capability of playing sound files. It has been specifically developed for the robotherapy application. The stories, questions, songs involved in therapy sessions are stored as sound files and played back using this BICA component.

The behavior based organization of the software of the robot in BICA allows a modular development of robot functionalities, with new components to accomplish new robot tasks or to perceive new associated stimuli.

Beyond the humanoid behavior in the RoboTheraphy application, this architecture has also been used for the programming of humanoid behaviors in other scenarios like the RoboCup competition. We have developed several perceptive and actuation components for the robot soccer player inside the RoboCup Standard Platform League. Some actuation components were programmed as PID reactive controllers and others as Finite State Machines, depending on the complexity of the behavior.

B. Tools: JManager

Several tools have been also created to ease the development of robot applications in BICA. JManager is an external application which centralizes the component debugging and monitorization tools developed for the BICA framework. This tool lets to set up the components, activate, deactivate and modulate them on the fly. The graphical output of some components can be shown on their corresponding tab in JManager. Each component may have an specific tab inside JManager for its debugging. For instance, a color filter tuner tab is shown at Figure 3, which lets us select on the fly the right thresholds for the color filter component.

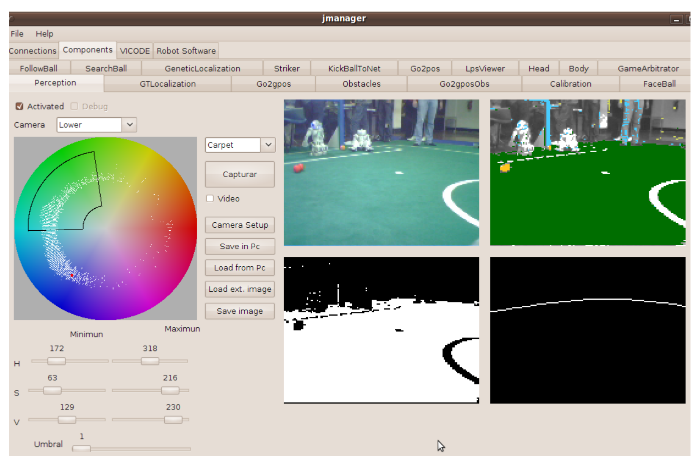

Fig. 3. JManager tool to activate BICA components and debug them

JManager runs at an external computer and connects to the BICA software inside the Nao humanoid using an ad-hoc communication protocol through the wireless or wired network connection. It has been programmed in Java.

C. Tools: VIsual COmponent DEsigner

Some actuation components may be successfully programmed as reactive controllers or simple PID feedback controllers. Many times the complexity of the components fits well in finite state machines (FSM). Using FSMs powerful components can be programmed, which unfold complex behaviors.

But developing complex behaviors based on FSMs directly in C++ may be complicated and prone to errors. Because of this we have developed a useful tool, named VICODE (VIsual COmponent DEsigner), that automatically generates C++ BICA component code from a visual description of the finite state machine 4. We use VICODE for the development of complex components, and even for the basic ones, as the code generation is faster and more reliable using it than writing the code manually.

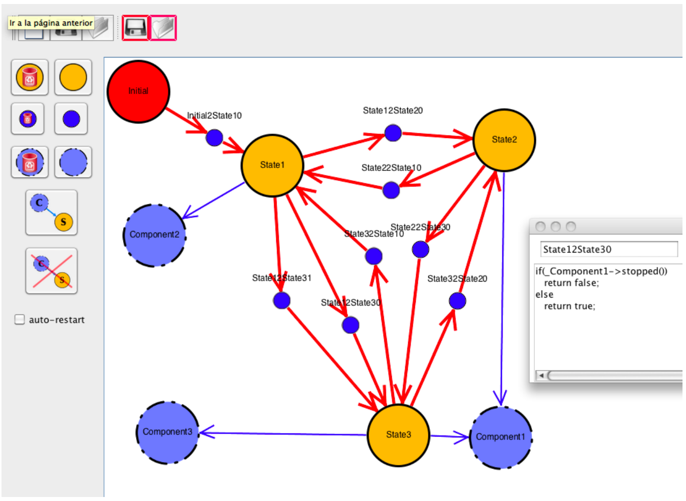

Fig. 4. Example of a FSM for a robot behavior using the VICODE tool

This tool lets us design an iterative finite state machine setting its states and transitions. Each state has a source code attached to be run at each iteration of the FSM being in such state. At the same time it has a source code to check possible transitions from it to other states when certain perceptive conditions are met. Furthermore, we can visually establish which components are used in each state, and whether it is a modulation or a requirement link. VICODE is included in the JManager tool as a tab.

VICODE generates the component C++ code. This includes the state machine code, the headers file with the component API, and calls to the `step()` method of the components that it uses or modulates. VICODE lets us to edit the states and transitions code. This code is even refreshed if the code is externally edited to avoid inconsistencies. Transitions are defined as functions that return true or false if the transition has to be taken. This information to make the decisions can be provided by other components or by a timer (used for timebased transitions).

IV. Robot Software for Robotherapy

We have developed several software pieces for the use of humanoids in dementia therapy. The robot behaviors in therapy sessions are described mostly as a sequence of basic movements, music or text playing and light turning on-off operations. A file format syntax has been developed to store these behavior descriptions, they are called *session scripts*.

Some specific components inside BICA have been developed, like one that runs session scripts or other that provides access to robot lights from application software. In addition, some new tools have also been created: a session script generator that allows an easy and visual "programming" of robot behavior in therapy sessions, and session monitoring tools that help to the therapist to control the session progress. They are all described in this section.

A. Session script generator

The robot behavior set required for robotherapy application is smaller than for other fully autonomous applications like the robotic soccer in RoboCup. In essence, the robot behaviors in therapy sessions are described mostly as a sequence of basic movements, music or text playing and light turning on-off operations. They are usually launched together as the robot may be playing a song and dancing at the same time, for instance.

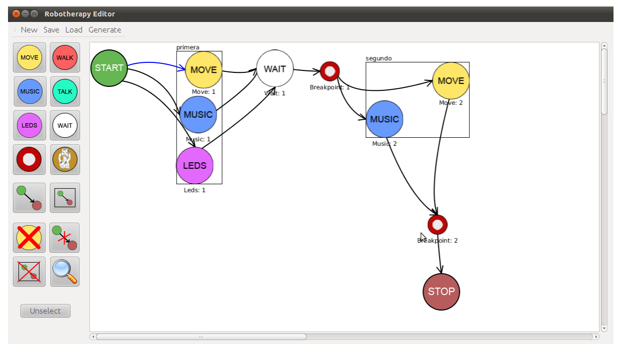

Fig. 5. Session script generator

A high level language has been developed to store these behavior descriptions. They can be stored in text files following a given syntax and read from them. They are called *session scripts*. The language includes three basic instructions: `move`, `music` and `light`. Two or three basic operations of different type can be grouped together, in group instructions, to be executed simultanously. The robot behavior is a sequence of these basic or group instructions. In the script some synchronization points can be included to wait for the termination of all the basic intructions inside a group. In addition, the `wait` instruction causes the robot to stop execution until the therapist provides the continue order, striking one button in the robot body, or in the Wiimote, or using any monitoring tool. This allows the therapist to control the session progress.

```
move introduction
music /home/nao/mp3/sound02.mp3
wait task mov
wait task music
wait press left
breakpoint
```

Fig. 6. Robot session script example

The scripts are generated and stored in text files. The example in Figure 6 starts two actions: the robot movement task and the playing of a sound file. The `move` command accepts a file with the robot position sequence. The `music` command accepts the file with the sound to be played. Then waits until both tasks have finished. Then waits until the robot left button is pressed. The contents of the real sessions are designed by medical doctors and health assistants, attending to the desired stimulation in the dementia patients. At the beginning they were created directly editing text files. Recently we have developed a graphical tool, the session script generator (Figure 5), that allows a fast and visual creation of these scripts.

B. Movie component

One specific component has been developed inside BICA for the robotherapy application, the `Movie` component. It accepts session scripts as input and runs the corresponding orders to robot motors and actuators, at the proper timing, unfolding the specified robot behavior. It uses several HAL components available in BICA, like the `Body`, `LED`, `Music` and `Head` components, as shown in Figure 7.

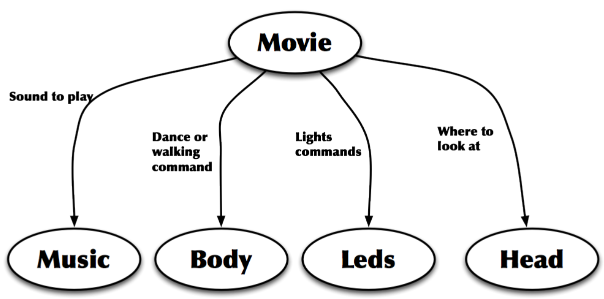

Fig. 7. Movie component in BICA runs session scripts on board the robot

For dancing the robot has previous descriptions of its movements. They are stored as single files following a given syntax, and they can be referenced in the scripts run by the `Movie` component. Those movement files include the position of all robot joints and the right time for each one. For singing or story telling the corresponding song and text are stored as sound files, and they can also be referenced in the session script.

C. Session monitoring from a computer

The therapist needs a way to communicate with the robot, to start a robotherapy session, to stop its execution while the patients answer one of the robot questions, to repeat any script step, etc.. The initial basic interface with the real robot is the set of buttons on its feet and chest. At the beginning these buttons were used, but we developed three session monitoring applications to allow an easier way to control the robot.

The first session monitor is an application running on a regular computer. It offers a Graphical User Interface with sliders, selectors, visual buttons, etc. as shown in Figure 8. It allows the teleoperation of the robot body and head, in order to approach the robot towards the patients at the beginning of the sessions, for instance. It can be operated from an external personal computer or a laptop.

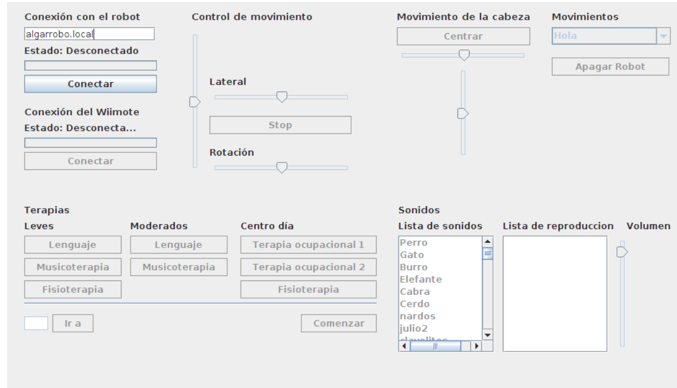

Fig. 8. Session monitor at a regular computer

D. Session monitoring from a tablet

In order to improve the tool usability, a second session monitor has been created that runs on mobile devices like Android tablets or smartphones (Figure 9). Using it no extra computer is required, just the robot and the tablet or smartphone. With this monitor the therapist has full control of the progress of the therapeutic session.

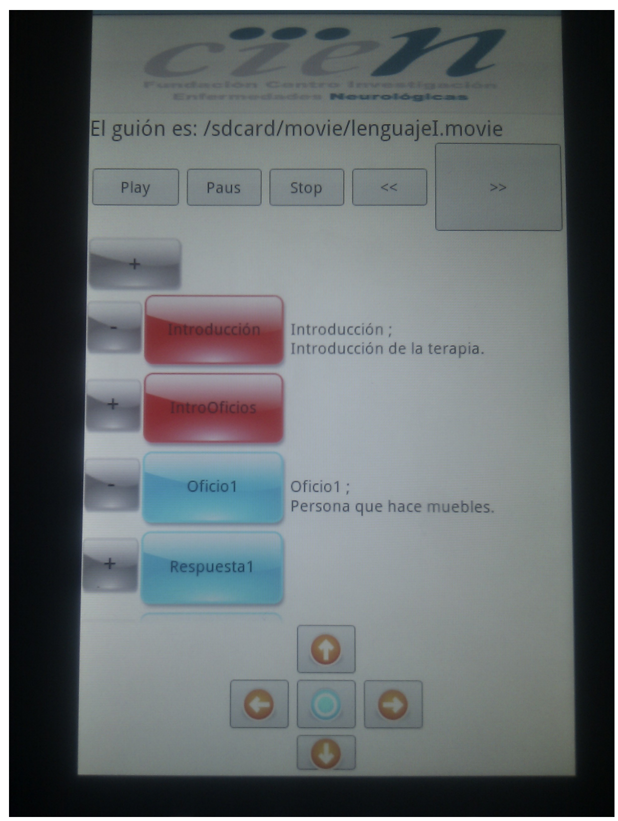

Fig. 9. Session monitor at a tablet

Interaction between different BICA components is performed as local method invocation of other component objects. An specific module has been developed for communication between BICA and software outside the robot, for instance the communication between these session monitor tools and the `Movie` component onboard the robot. This module and the session monitor use ICE as communication middleware, both in the robot side and in the Android side of the system (smartphone or tablet) (Figure 10).

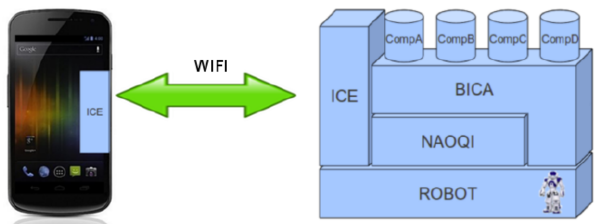

Fig. 10. Software design of the Android support

E. Session monitoring from Wiimote

The session monitor can be used in conjuntion with a *Wiimote*. This device is more convenient than the regular screen, keyboard and mouse configuration. In this case the session monitor reads the therapist orders from the *Wiimote* buttons and accelerometers using bluetooth (Figure 11).

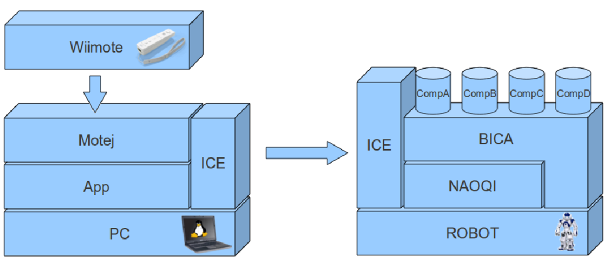

Fig. 11. Software design of the Wiimote support

An external application, named Motej and written in Java, receives Wiimote data using via bluetooth and sends them to the `Movie` component inside the robot. It works on a off board computer (as the robot hardware does not include bluetooth) and uses ICE for that communicacion.

V. Experiments

The platforms available for this project were initially three: the robot seal Paro, the Aibo robot dog and the Nao humanoid. One of them needed to be selected for the real experiments.

The mobility of the robot seal Paro is mainly confined to its head (its eyes move). It also produces sounds that simulate those of a baby seal. The robot dog Aibo and the Nao humanoid offer much more functionality: they are both also nice to look at, they walk, move their head, have lights and make sounds. The larger size of humanoid makes it more visible than the robot dog. In addition, the humanoid robot is most useful in physical therapy, as it can perform physical exercises that can be directly mimicked by patients. This is a key issue.

From a technical point of view, the development of software for the robot seal Paro is complicate because it is a closed platform. Our group has extensive experience in the programming of the other two platforms in the RoboCup environment. One difference in favour of the humanoid robot Nao is the availability. Although we have several Aibo robots and it was a bestselling commercial robot, since 2008 its manufacturing has been discontinued. Currently our group is participating in the RoboCup with the Nao humanoid, and the software architecture developed to control the robot in this environment, BICA, is general enough to host the robot software for the robotherapy application.

The Aibo and humanoid robots were tested with real patients to see their acceptance (Figure 12). The Nao robot was presented to a group of 20 patients with differing severity of dementia. The humanoid robot was accepted by most of them: 80% showed a very positive attitude, 15% did not react and 5% (one person) showed aggression towards the robot (and also to therapists and psychologists). Most patients identified him as a child and tried to talk to him.

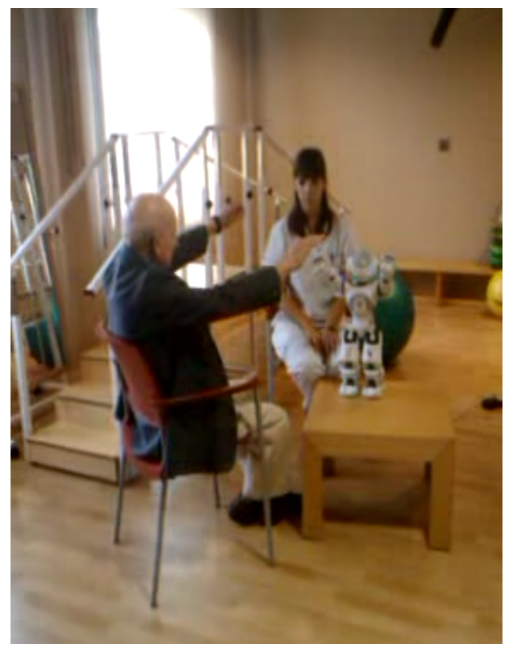

Fig. 12. Nao acceptance test

For all these reasons, the Nao humanoid was the selected platform. Nao robot is a fully programmable humanoid robot. It is equipped with a x86 AMD Geode 500 MHz CPU, 1 GB flash memory, 256 MB SDRAM, two speakers, two cameras (non-stereo), Wi-Fi connectivity and Ethernet port. It has 25 degrees of freedom. The operating system is Linux 2.6 with some real-time patches. The robot is equipped with an ARM 7 micro-controller allocated in its chest to control the robot's motors and sensors, called DCM.

A. Therapy sessions

The therapy session contents have been designed by therapists specialized in the disease of dementia. The robotics work focused on developing the software required so that these sessions can be carried out with maximum similarity to how they were conceived. We developed all the required software components, sounds and robot movements, and proposed new tools to be used and evaluated.

Fig. 13. Real session with dementia patients using a humanoid robot

We performed cognitive therapy and physiotherapy sessions, 2 days/week during one month with a humanoid robot in a group of 13 patients (Figure 13). Evaluation at baseline and follow-up was carried out with scales to detect apathy, quality of life and dementia severity. Most of the patients had moderate-severe dementia (Figure 14), mean age 83.2 years (range: 74-91) and 92% were women.

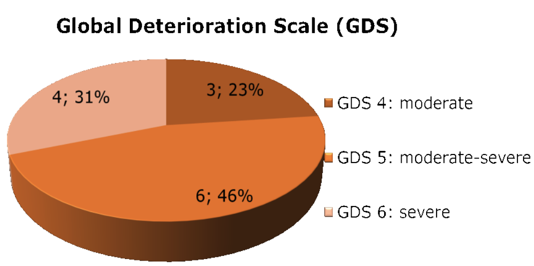

Fig. 14. Global Deterioration Scale of the group involved the experiments

Each session took between 30 and 45 minutes, and was recorded by two cameras. We designed four types of sessions: language, music therapy, storytelling and physiotherapy. Cognitive therapy included music therapy, playing activities and language sessions. In the language sessions the robot asked about numbers, days of the week and set riddles and questions aimed at cognitive activation. In the music therapy sessions the robot combined basic questions related to popular songs. Physiotherapy sessions (Figure 15) consisted of a set of exercises that the robot explained and performed: movements of arms, head, torso and walking exercises. In storytelling sessions the robot told a story, moving itself and turning its lights on at the same time, there was no direct interaction with patients.

The sessions for patients with severe dementia cannot be structured as those for people with moderate dementia because they are unable to maintain attention long enough to be

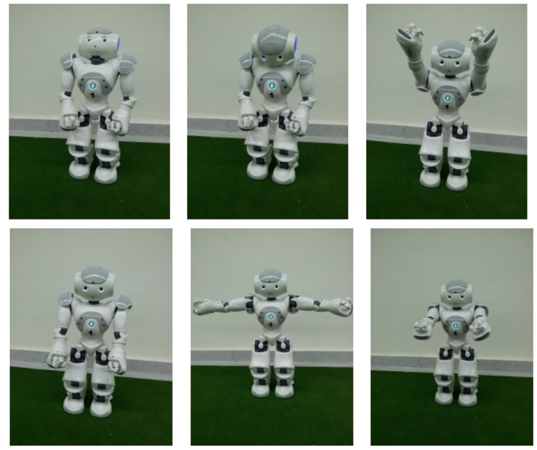

Fig. 15. Robot movements in physiotherapy session

effective. For them we designed a set of activities to be carried out by the robot: walking towards a patient, looking at her face, making sounds of animals, etc. - these actions seemed to improve their apathy. Some of these activities (walking towards a patient and looking at her face) were also applied during the sessions with the rest of the group, also improving their responses. To carry out these activities, we extended the software and robotic tools to be easily managed by the therapists. The Wiimote extension of the session monitor and the tablet-based session monitor has been developed after observing in the experiments the autonomy needs of the therapists.

B. *Preliminary medical results*

Some preliminary medical results have been presented in medical forums and are better explained in [15]. All scales showed a trend to improvement in neuropsychiatric symptoms, apathy and quality of life, although Wilcoxon test showed no significant statistical differences between baseline and follow-up. Patients accepted well the robot and participate as actively in therapy sessions with robot as in the regular sessions.

This pilot study showed that a clinical study using robots for cognitive therapy in dementia institutionalized patients is possible. Currently we are using robots as a new tool for dementia therapists in a pilot clinical assay to discover the effect of this new non pharmacological treatment compared to habitual treatment. We involve more than a hundred patients, use a control group to compare and the evaluators are blind to the therapy.

VI. Conclusions

In this paper we have presented a cutting edge application of humanoid robots in the therapy of dementia patients.

We have developed several software pieces to support this application. First, our BICA software architecture integrates all robot perceptive and actuation capabilities. Second, a software module helps to visually generate session scripts. These session scripts are simple descriptions of robot behaviour sequences during the therapeutic sessions. They involve music playing, movements and light generation capabilities onboard the humanoid. They have been created with the knowledge and support of medical experts, and are stored in single files. Third, a software module inside BICA runs the session scripts on the real robot. Fourth, a monitor module allows the human therapist to control the script execution, proceeding with the next behaviour, repeating steps, etc., and so modulating the session development. Two different monitors have been developed, one running on a regular PC and another one running on an Android tablet. The Wiimote device support has also been incorporated for easy robot control by the therapists, improving their autonomy.

Four kinds of sessions have been prepared and performed: storytelling, music therapy, physiotherapy and logic-language therapy. In music sessions, the robot plays songs from the years when the patients were young, trying to stimulate their emotions. In physiotherapy sessions, the robot performs several physical exercises with the intention of being repeated by the patients. Logic-language therapy is based on several simple questions to cognitively stimulate the patient responses.

The preliminary medical results on real patients with moderate dementia are promising. Their neuropsychiatric symptoms tend to improve over those of patients following classic therapy methods, but further research is required. Surprisingly the robot captures the attention of the elderly due to its human shape, its movements and music capabilities.

We are working on extending the direct interaction between the patients and the humanoid robot. For instance, the real patient showing coloured cards to answer questions set by the humanoid. Also we are programming the robot with more autonomous behaviours like face tracking or people following.

Acknowledgment

This work was supported by the project S2009/DPI-1559, RoboCity2030-II, from the Comunidad de Madrid, by the project PI10/02567 from the Spanish Ministry of Science and Innovation and project 231/2011 from IMSERSO. Authors also want to acknowledge the collaboration of the patients, their relatives, the therapists and evaluators, in particular Luis I. Casanova, Sara Saiz, Cynthia Prez, Emma Osa, Elena Ortega, Ana Casarrubio, Cristina Martn and people from UMA group.

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CHAPTER X

Robots applied to Dementia: A practical experience

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Personal assistance robotics has increasingly become an importante focus of attention in robotics research in recent years. The age of the population is growing and it requires more resources to their care. Robots are becoming a good alternative to ensure elder care. This application requires a collaboration between reasearches on health and robotics disciplines to develop new metohodologies and tools for assitive robotics. This article describes the experience of several years on using robots in therapies for dementia patients. We present the key features of the study, the main actors involved on it and the methodology developed. Our intention is to describe the methodology carried out in order to be useful for scientific who start similar iniciatives. This study has been carried out with real patients and real robots in collaboration with a centre of research in neurodegenerative diseases. As a result of the use of the robot in therapies, we achieved a slight or mild improvement in neuropsychiatric symptoms over other traditional therapy methods.

1 Introduction

Traditionally, Robotics is focused on developing robots which help humans to perform dangerous or tedious tasks. In recent years, robotics has evolved from traditional industrial or research to home environments where robots share this space with common people for being a companion or helping the daily task. In countries like Japan, where the population is becoming older, the robots are emerging as the caregiver of the future. For this reason, the assitive robotics assistance is receiving an increasing attention. In assistive robotics discipline not only researchers are involved, but doctors and psychologists. The basic idea is to design platforms and applications adequately to support humans who require special care due to illness or their old age. Assistive Robotics occupies a preferential role in AAL technologies (Ambien Assitive Living), focused on designing future spaces where humans (specially old or sick peope) live constantly assisted by the resources that technology can provide.

The application of robots in the therapies on cognitive disorders have focused mainly to autism and dementia. Unfortunately, most of the work is focused on the development of robotic platforms handcrafted whose replication is not enough affordable for a widespread application. Often, the design of these platforms has no the direction of groups of psychologists, resulting inefficient to the goals pursued initially. In recent years, emerging commercial robotic platforms are carefully designed to be visually pleasing and to awake human empathy, suitables for asstive or pets applications. Moreover, the cost of these platforms is affordable, providing spare parts and repair services. These factors are crucial when you want to generalize healthcare applications.

This paper provides a practical experience in the application of robots in therapy in patients with dementia. This is intended as a reference for scientists who start similar studies. When we began this study there was not similar experience as references. Even today there are serious works like this. The goal of this study is developing an effective tool which can be used by therapists during cognitive therapy sessions and so enhancing the effect of the existing therapies without robot. This was carried out in several stages in which sequentially analyzed robots accepting candidates, the viability of the approach and long extensive analysis. Failure in any of these phases would have led to the complete rethinking of the study, or even cancellation. Fortunately, the phases have performed reasonably successful to initial expectations.

We will describe this study, conducted with real patients, real environments and real robots during a period of just over two years. The working group consists of researchers in robotics and researchers in neurodegenerative diseases. After an initial evaluation, which will be described in this article, the robotic platform is the humanoid robot Nao (Fig. 1). The technical description of the infrastructure has been widely presented in

(Martin, 2013) , but the goal of this paper is giving a strong review of the application of robotic technology analysis.

Fig. 1. Humanoid Robot Nao

After presenting the works related with this study and the metodology used, the steps of the study will be described in a chronological. In section 5 will provide quantitative results of the study with a real robot with real patients.

2 Related work

In recent years there have been an increasing interest in AAL technologies. There are several projects in the eurpean FP7 program which support this research field: Mobiserv[1], Companionable[2], Domeo[3], Florence[4], KSERA[5] and SRS[6]. The goal of these projects is to design an environment for elderly care, where robots are fundamental pieces of interaction. Of these projects have emerged overviews systems (Pigini, 2011) and methodologies (Garzo, 2012) (Renteria, 2012) generalizable. (Broekens, 209) systematic reviews the literature on the effects of social robots in the health care of the elderly, especially in the role of company for the patient. The robotics platforms are wheeled, equipped with tactil screens to interact

[1] http://www.mobiserv.eu/
[2] http://www.companionable.net/
[3] http://www.aal-domeo.org/
[4] http://www.florence-project.eu/
[5] http://www.ksera-project.eu/
[6] http://srs-project.eu/

with humans (Fig. 2). Among the works of robotics applied to therapy, we can reference the works carried out by the Aurora project with children with autism (Ferrari, 2010) and several robotic platforms.

Prof. Mataric Matja also pioneered the development of robotic platforms for therapy with autistic children and with dementia (Tapus, 2008) (Tapus, 2010). The platform is handcrafed (Fig. 3, right) and the experiments are limited to small test without a rigorous medical analisys.

Fig. 2. Robots involved in FP7 AAL projects

The robot Paro (Fig. 3, left) is probably one of the commercial robots applied to cognitive therapy better known diseases. His appearance baby seal awakens empathy for patients, but their capabilities are very limited limitdas and making sounds and moving the eyelids in response to touch. The only work that provides experimental results to its application is (Wadal, 2007). In this paper, the robot is a passive element placed on the table in a residence. This robot catches the attention of patients and gathers around the robot, measuring the increase in the interaction between patients, motivated by this congregation.

Fig. 3. Robot Paro (left) and robot developed at USC (right)

3 Robot evaluation

The physical appearance of a robot is crucial in relation to a human. If a person feels intimidated or anxious about the robot, the interaction will not be full. If the objective is to awaken a positive reaction from a patient, this factor should be taken into account. There are several studies on the acceptance of a robot by human beings. Probably the most famous is the case of the uncanny valley (Masahiro, 1970). This work relates the degree of acceptance of a robot as a human appearance when it approaches to the human one. Figure 4 can see how our brain reacts to rejection when a robot looks too much like a human, without being exactly identical. "Rejection" is a strong word, but it's reality, and we should pay attention to this factor. Besides the similarity to a human, factors as the relative size with respect to the patient or the robot design are important for a nice and effective interaction.

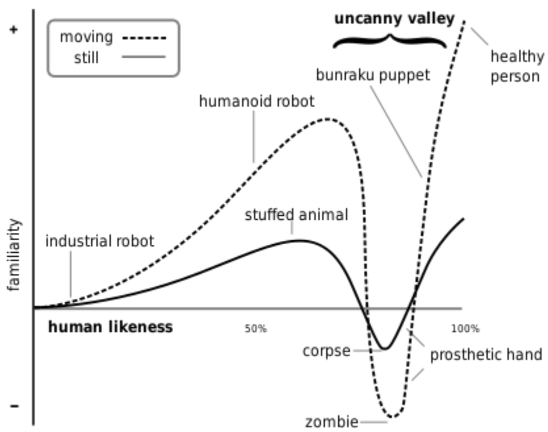

Fig. 4. Uncanny Valley

The first phase of our study was to evaluate the platforms available at the time by our group: the seal robot Paro, the robotic dog Aibo and the Nao humanoid. This test was carried out with patients of moderate/mild dementia grade. We presented the robots at duty and several experts analized the reaction of the patients. In all cases patients paid attention to the robots and they did not feel intimidated by the robots. They were very likely to interact with them. The seal robot Paro made the shortest reaction due to its limited capabilities. Experts believe that this robot is designed to make arise feelings of empathy for the patient, and so its application is more effective applied to patients with autism. The other two robots had a longer effect. We were afraid that they would not feel interested for any of them, or they could produce any fear on them. With this results, we considered this test as satisfactory.

Fig. 5. Robot evaluation session

Once identified the reaction of the patients, we had to take a decission between Aibo and Nao. Both of them are equipped with the basic elements needed for the desired interaction: cameras, microphone, lights, speakers and touch sensors. Our recommendation was the Nao robot because it is easer to develop application for it, repairs and the human design is useful for phisiotherapy sessions.

4 Designing therapy sessions and interfaces

Therapy sessions with patients with dementia aim cognitive and psychomotor stimulation. Cognitive stimulation therapies were based on riddles problems, calculation, memory stimulation and music therapy. There is also a separate session of physiotherapy, conducted by a physical therapist, patients trying to conduct a basic gymnastics in the best of its ability.

The first option was to adapt these therapies to be performed by the robot, always controlled by a therapist or physiotherapist. The session were coded into sequential scripts. It is essential that a therapist design of the robot actions to be carried out in the therapy sessions. The robotics expert can only advise which actions the robot can perform and which not. It is important to share with therapists that the robot will always be a tool that enhances the effect of their work and that the robot will never replace the therapist. The collaboration of the therapist is key to the success of the project and if this point is not clear, there may be fears when collaborating in the study.

Fig. 6. Tecnical support during a session. Therapist uses a Wiimote to teleoperate the robot

One of the main tasks of roboticist is to provide the effective tools to therapist to properly control the operation of the robot during therapies. The robot is always connected to a wifi network, which could send commands to the robot. At initial, the therapist was assisted by a technician (Fig. 6) connected to the robot. Its unique interface with the robot were the buttons, which were used to advance the therapy script. The technician was who tele-operated robot to walk or move his head to simulate patients watched it. Subsequently, we used a control equipped with buttons and accelerometers (Wiimote) for the therapist to control the movement of the robot. Finally, the therapist's tool is a tablet which controls the movement of the robot and random access to any point in the script.

5 Study design and evaluation

The study aims to measure the impact of the robot as a tool in therapy. This study was conducted in several phases. At the end of each phase an evaluation was made based on the recorded video. The following describes these phases and features:

Fig. 7. Therapy session with real patients

1. **Pilot study**: Two groups of patients (mild and moderate) of 10-15 patients. Sessions of 30-45 minutes each. The duration of this phase was three months and aimed to test the feasibility of this approach.
2. **Extensive phase**: Three groups of patients (mild, moderate and severe). We compared three types of sessions: with robot with robot robot off without. This study was carried out in three control groups with 10 to 15 patients for 24 months. During this period there patients who, due to the degenerative nature of their condition, migrated group.

To evaluate the effects of using the robot in therapy, all sessions are registered on video for 3-4 cameras (Fig. 7) located at different positions to cover the reactions of patients. Neurodegenerative disease experts analyze these videos to compare the effect of the sessions with robot and robot sessions. Measure factors such as apathy, aggression, etc ...

6 Conclussion

Some preliminary medical results have been presented in medical forums and are better explained in [15]. All scale showed a trend to improvement in neuropsychiatric symptoms, apathy and quality of life, although Wilcoxon test showed no significant statistical differences betwee baseline and follow- up. Patients accepted well the robot and participate as actively in therapy sessions with robot as in the regular sessions.

This study showed that a clinical study using robots for cognitive therapy in dementia institutionalized patients is possible. Currently we are using robots as a new tool for dementia therapists in a pilot clinical assay to discover the effect of this new non pharmacological treatment compared to habitual treatment. We involve more than a hundred patients, use a control group to compare and the evaluators are blind to the therapy.

Beyond the medical results, we have proved an effective methodology to analyze the impact of a robot in therapies. As weaknesses, you should increase the number of patients on this study and limit its duration for the groups are constant and are not unduly affected by the evolution of the disease. The next steps are to increase the study population, redesign therapies to increase their effectiveness and evaluation of new robotic platforms (cheaper and equally effective).

Acknowledgements

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RoboTherapy with Alzheimer patients

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***Abstract*—Humanoids have become an increasing focus of attention in robotics research in last years, especially in service and personal assistance robotics. This paper presents the application developed for humanoid robots in therapy of Alzheimer patients, as a cognitive stimulation tool. The behavior of the robot along the therapy sessions is visually programmed in a session script that allows music playing, physical movements (dancing, exercises...), speech synthesis and interaction with the human monitor. The application includes the control software onboard the robot and some tools like the visual script generator or a monitor to supervise the robot behavior along the sessions. The robot application's impact on the patient's health has been studied. Experiments with real patients have been performed in collaboration with a centre of research in Alzheimers disease. Initial results show a slight or mild improvement in neuropsychiatric symptoms over other traditional therapy methods.**

***Index Terms*—Social Robotics, Humanoid robot, Robot Therapy**

I. INTRODUCTION

ONE field of growing interest in robotics are humanoids. Prototypes such as the Honda Asimo or the Fujitsu HOAP-3 are the basis for many research efforts, some of them designed to replicate human intelligence and maneuverability. Their appearance similar to people facilitates their acceptance and natural interaction with humans as a personal assistant in the field of service robotics, for instance. As a representative sample, the functionality achieved in the Asimo humanoid has progressed significantly in recent years, allowing it to run, climb stairs, push carts and serve drinks.

On other hand, neurodegenerative dementia is a disease that progressively deteriorates brain functionality. One of the most common symptoms of dementia is memory loss. In addition, patients usually lose the ability to solve problems or control their emotions and present changes in personality and normal behavior. Over time, people with dementia are unable to properly perform the basic activities of daily living such as maintaining personal hygiene or food. Estimates point that in 2016 there will be 26.6 million people worldwide with Alzheimer's disease, and this figure will be three times bigger by 2050. On that date, the Alzheimer will affect 1 in 85 people of the total world population. And 40% of them will be in an advanced state of disease, requiring a level of care that involves high consumption of resources [1].

While there is no causal cure for the disease, palliative medication and nonpharmacological therapy are the only ways patients can improve symptoms and slow down its progression.

Nonpharmacological therapy focuses on strengthening the activities mentally, physically and emotionally. Such actions seek to maintain the functional capacity of the person, while ensuring her levels of quality of life and autonomy. Animal therapy has also shown good results, especially with elderly that live alone. However, it is not always possible. Sometimes the entrance of animals in elder residences it is not allowed due to health and safety reasons. Other times it is the cost of maintaining these animals and the care they need which precludes their presence in the residence. Another issue to consider is that the therapeutic interaction at the cognitive level needed in older people with dementia is not resolved with the presence of animals in the environment of the patient [2].

Regular therapy includes several sessions per week with a human therapist monitoring a group patients. The therapist asks them simple questions, tells them stories, talks to them, interacts with them, hugs them, suggests games, riddles or guides them while doing physical exercises. These activities pursue the cognitive, affective and physical stimulation of the patients.

In this paper we describe the use of a humanoid robot as a cognitive stimulation tool in therapy of Alzheimer patients. Several software modules have been programmed to generate the robot behavior in the therapy sessions. Three types of robotherapy sessions have been developed: physiotherapy, music and logic-language sessions. The robot and the developed software have been used in a pilot study with real patients to evaluate the feasibility and usefulness of robots in dementia therapy.

The remainder of this paper is organized as follows. Second section presents some works with social robots and their use in dementia therapies. Third section explains all the software developed for this humanoid application, including some tools designed to visually program the robot behavior for the robotherapy sessions. The fourth section describes the experiment performed with real patients to measure the impact of this robotic tool on their health and some preliminary results are presented. Finally, some conclusions are summarized.

II. RELATED WORKS

The interest in social robots is growing, as one of upcoming application fields of the next generation robots. For instance as game platforms [3], personal assistants, nursing robots [4] or assistive tools in rehabilitation [5].

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In the past 5 years, several projects have been initiated with the therapeutic use of social robots [6] as reasonable substitutes for animal therapy in people with dementia. Robots do not involve the responsibility or the need for an animal facility and their sensors can respond to environmental changes (movements, sounds ...) simulating an interaction with the patient [7]. At the same time, they provide the opportunity to monitor patients and perform cognitive therapy, unlike animal therapy [8]. Other potential benefits of therapy with robots are that it has no secondary effects (like drug therapy) and does not require specially trained personnel (as opposed to the other therapies such as music therapy, pet therapy, etc..).

The Paro robot, which has seal shape, has been used in dementia therapies [9] with positive results.

Broekens et al published in 2009 [10] a systematic review analyzing the literature on the effects of social robots in the health care of the elderly, especially in the role of the company to the patient. It is noteworthy that all studies are after 2000, which indicates the novelty of this research area. Most studies have been conducted in Japan, Southeast Asia and the U.S. [11]. The main results of analysis of these studies are:

- Most of the elderly like robots.
- The shape and material of the robot influence the acceptance and the effect of the robots.
- Improving health by lowering stress levels (measuring stress hormones in urine) [12] and increased immune system response [13].
- Improvement of humor (through surveys and the evaluation of facial expressions)
- Decreased sense of loneliness (using scales measuring loneliness)
- Increased communication (measured by the frequency of contact with robots and family).
- Remember the past (especially with a robot as a baby).
- Some studies indicate that the use of robots helps to reduce the severity of dementia in some patients.

III. Robot software for robotherapy

We created a programming framework, named Behavior-based Iterative Component Architecture (BICA) [14], to develop autonomous applications for our humanoid robots. It has been used in research for several years around the RoboCup environment, and it has also been used for robotherapy.

We have developed several software pieces for the use of humanoids in therapy. The robot behaviors in therapy sessions are described mostly as a sequence of basic movements, music or text playing and light turning on-off operations. A file format syntax has been developed to store these behavior descriptions, they are called *session scripts*.

Some specific components inside BICA have been developed, like one that runs session scripts or other that provides access to robot lights from application software. In addition, some tools have also been created: a session script generator that allows an easy and visual "programming" of robot behavior in therapy sessions, and the session monitor tool that helps the human therapist to control the session progress. They are all described in this section.

A. BICA architecture

The software of our humanoid robot is organized with a behavior-based architecture. It is implemented in a component oriented software architecture, BICA, programmed in C++ language. Components are independent computation units which periodically execute control iterations at a pre-configured frequency. Every component has an interface to modulate its execution and to retrieve the results of its computations.

Behaviors in BICA are defined by the activation of perception components and actuation components. Actuation components take movement decisions, send commands to the robot motors, or locomotion system, or activate other actuation components. They run iteratively to periodically update their outputs. Perception components take data from robot sensors or other perception components and extract information. They basically provide information to the actuation components. The output of a perception component is refreshed periodically and can be read from many other components in the system.

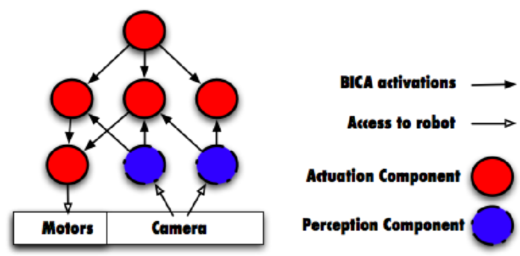

Fig. 1. Behavior in BICA composed by actuation and perception components

Not all the perception capabilities of the robot must be active at the same time, consuming computing resources. Even more, the whole set of behaviors that the robot is able to eventually perform is not suitable to deal with the current situation. Only a subset of behaviors and perception units are relevant to the current situation. In BICA each component is activable and deactivable at will, so it remains inactive until the situation demands it, when another component activates it. Typically an actuation component activates the perception components it requires and the child actuation components (if any) that implement its control decisions. This activation chain creates a dynamic component tree to cope with the robot's current situation. Figure 1 shows an component activation tree with both perception and actuation components.

Beyond being a framework to integrate perceptive and actuation capabilities for autonomous behaviors, the BICA architecture also includes components that provide access to the basic sensors and actuators of the robot, a Hardware Abstraction Layer (HAL) for robot applications. BICA is built on top of Naoqi, the manufacturer middleware, and offers this HAL as a set of object method invocations. For instance, the `Body` component provides access to the motion capabilities, both the legged locomotion and the arm movements. The `Perception` component provides access to the camera images. The `LED` component provides access to several lights on the robot head and chest, which can be turned on and off from the application software. The `Head` component provides access to the neck of the humanoid, allowing to rotate the head horizontally or vertically. The `Music` component provides the capability of playing sound files. It has been specifically developed for the robotherapy application. The stories, questions, songs involved in therapy sessions are stored as sound files and played back using this BICA component.

The behavior based organization of the software of the robot in BICA allows a modular development of robot functionalities, with new components to accomplish new robot tasks or to perceive new associated stimuli.

Beyond the humanoid behavior in the RoboTheraphy application, this architecture has also been used for the programming of humanoid behaviors in other scenarios like the RoboCup competition. We have developed several perceptive and actuation components for the robot soccer player inside the RoboCup Standard Platform League. Some actuation components were programmed as PID reactive controllers and others as Finite State Machines, depending on the complexity of the behavior.

B. Session script generator

The robot behavior set required for robotherapy application is smaller than for other fully autonomous applications like the robotic soccer in RoboCup. In essence, the robot behaviors in therapy sessions are described mostly as a sequence of basic movements, music or text playing and light turning on-off operations. They are usually launched together as the robot may be playing a song and dancing at the same time, for instance.

A high level language has been developed to store these behavior descriptions. They can be stored in text files following a given syntax and read from them. They are called *session scripts*. The language includes three basic instructions: `move`, `music` and `light`. Two or three basic operations of different type can be grouped together, in group instructions, to be executed simultanously. The robot behavior is a sequence of these basic or group instructions. In the script some synchronization points can be included to wait for the termination of all the basic intructions inside a group. In addition, the `wait` instruction causes the robot to stop execution until the human therapist provides the continue order, striking one button in the robot body or using any monitoring tool. This allows the human therapist to control the session progress.

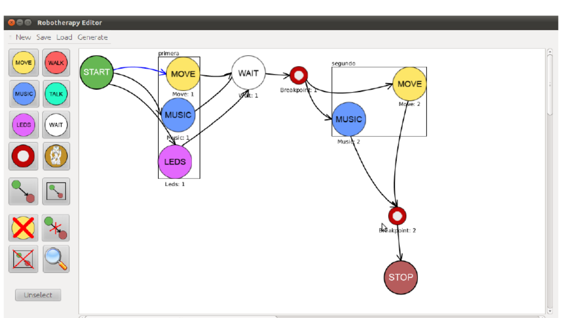

Fig. 2. Session script generator

The scripts are generated and stored in text files. Their contents are designed by medical doctors and health assistants, attending to the desired stimulation in the Alzheimer patients. At the beginning they were created directly editing text files. Recently we have developed a graphical tool, the session script generator (Figure 2), that allows a fast and visual creation of these scripts.

C. Movie component

One specific component has been developed inside BICA for the robotherapy application, the `Movie` component. It accepts session scripts as input and runs the corresponding orders to robot motors and actuators, at the proper timing, unfolding the specified robot behavior. It uses several HAL components available in BICA, like the `Body`, `LED`, `Music` and `Head` components, as shown in Figure 3.

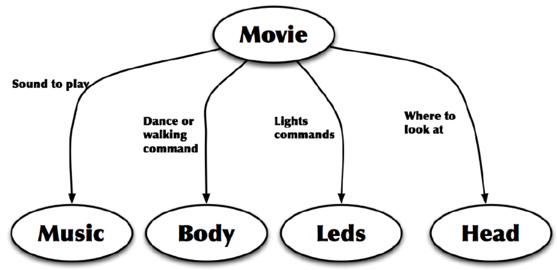

Fig. 3. Movie component in BICA runs session scripts on board the robot

For dancing the robot has previous descriptions of its movements. They are stored as single files following a given syntax, and they can be referenced in the scripts run by the `Movie` component. Those movement files include the position of all robot joints and the right time for each one. For singing or story telling the corresponding song and text are stored as sound files, and they can also be referenced in the session script.

D. Session monitor

The human therapist needs a way to communicate with the robot, to start a robotherapy session, to stop its execution while the patients answer one of the robot questions, to repeat any script step, etc.. The basic interface with the real robot was the set of buttons on its feet and chest. At the beginning these buttons were used, but we developed two session monitor applications to allow an easier way to control the robot.

The first session monitor is an application running on a regular computer. It offers a Graphical User Interface with sliders, selectors, visual buttons, etc. as shown in Figure 4. It allows the teleoperation of the robot body and head, in order to approach the robot towards the patients at the beginning of the sessions, for instance. It can be operated from an external computer, or used in conjuntion with a *wiimote*. This device is more convenient than the regular screen, keyboard and mouse configuration. In this case the session monitor reads the therapist orders from the *wiimote* buttons and accelerometers using bluetooth.

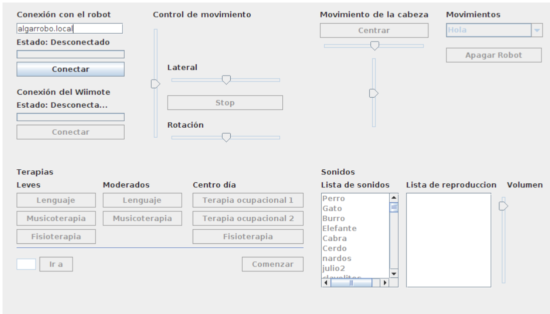

Fig. 4. Session monitor at a regular computer

In order to improve the tool usability, a second session monitor has been created that runs on mobile devices like Android tablets or smartphones (Figure 5). Using it no extra computer nor wiimote is required, just the robot and the tablet or smartphone. With this monitor the human therapist has full control of the progress of the therapeutic session.

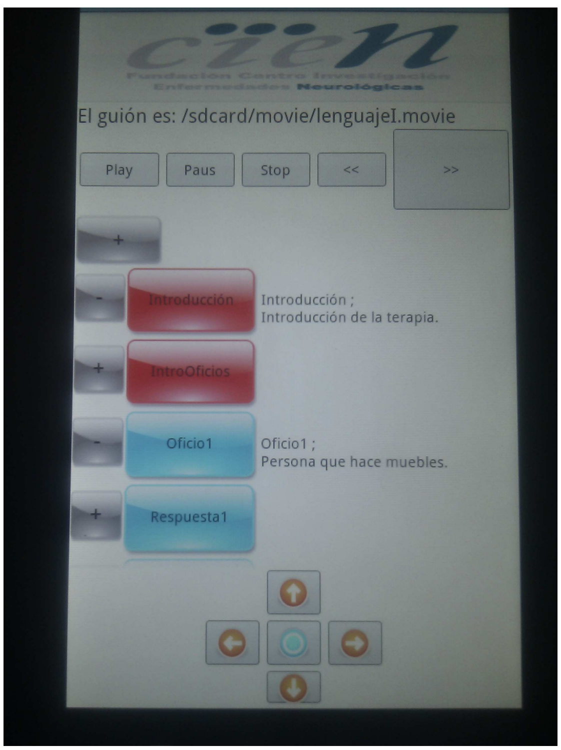

Fig. 5. Session monitor at a tablet

Interaction between different BICA components is performed as method invocation of other component objects. An specific module has been developed for communication between BICA and software outside the robot, for instance the communication between these session monitor tools and the `Movie` component onboard the robot. This module and the session monitor use ICE as communication middleware.

IV. Experiments

The platforms available for this project were initially three: the robot seal Paro, the Aibo robot dog and the Nao humanoid. One of them should be selected for the real experiments.

The mobility of the robot seal Paro is mainly confined to its head (it moves the eyes). It also produces sounds that simulate those of a baby seal. In the opinion of the involved neurologists in this evaluation, this robot is not effective in diseases of dementia, but better suited for patients with diseases related to autism.

The robot dog Aibo and the Nao humanoid offer much more functionality: they are both also nice to look, they walk, move their head, have lights and make sounds. At the beginning psychologists in the project team estimated that cognitive activation in patients would be similar with these last two robots. The larger size of humanoid makes it more visible than the robot dog. In addition, the humanoid robot is most useful in physical therapy, as it can perform physical exercises that can be directly mimicked by patients. This is a key issue.

From a technical point of view, the development of software for the robot seal Paro is complicated because it is a closed platform. Our group has extensive experience in the programming of the other two platforms in the RoboCup environment. One difference in favour of humanoid robot Nao is the availability. Although we have several Aibo robots and was a best-selling commercial robot, since 2008 its manufacturing has been discontinued. Currently our group is participating in the Robocup with the Nao humanoid, and the software architecture developed to control the robot in this environment, BICA, is general enough to host the robot software for robotherapy application.

Due to all these reasons, the Nao humanoid was the selected platform. Before making this selection definitive the robot was presented to a group of 20 patients with differing severity of the dementia. The robot was accepted by most of them: 80% showed a very positive attitude, 15% did not react and 5% (one person) showed aggression towards the robot (and also to therapists and psychologists). Most patients identified him as a child, and tried to talk to him.

Nao robot is a fully programmable humanoid robot. It is equipped with a x86 AMD Geode 500 Mhz CPU, 1 GB flash memory, 256 MB SDRAM, two speakers, two cameras (non stereo), Wi-fi connectivity and Ethernet port. It has 25 degrees of freedom. The operating system is Linux 2.6 with some real time patches. The robot is equipped with a ARM 7 microcontroller allocate in its chest to control the robot's motors and sensors, called DCM.

A. *Therapy sessions*

The therapy session contents have been designed by therapists specialized in the disease of dementia. The robotics work focused on developing the software required so that these sessions can be carried out with maximum similarity to how they were conceived. We developed all the required software components, sounds and robot movements and proposed new tools to be used and evaluated.

Fig. 6. Real sessions with Alzheimer patients

We conducted two experimental phases. In the first one we performed cognitive therapy and physiotherapy sessions, 2 days/week during 3 months with a humanoid robot in a group of 15 patients (Figure 6) and compared with conventional therapy (15 patients). Evaluation at baseline and follow-up was carried out with scales to detect neuropsychiatric symptoms and dementia severity. Most of the patients had moderate dementia (Figure 7), mean age 86.2 years (range: 74-100); 83.34% woman.

Each session took between 30 and 45 minutes and was recorded by three cameras. These recordings were later analyzed by experts to observe the reaction of patients. We designed four types of sessions: language, music therapy, storytelling and physiotherapy. Cognitive therapy included music therapy, ludic activities and language sessions. In the language sessions the robot asked about numbers, days of the week, made riddles and questions aimed at cognitive activation. In the music therapy sessions the robot combined basic questions related to popular songs. Physiotherapy sessions consisted in a set of exercises that the robot explained and performed: movements of arms, head, torso and walking exercises. In storytelling sessions the robot told a story, moving itselft and turning its lights on at the same time, there was no direct interaction with patients.

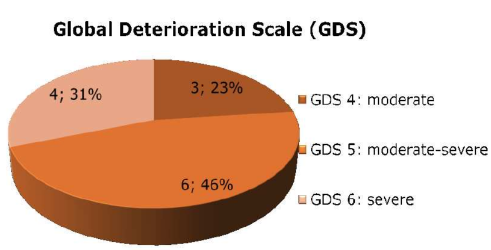

Fig. 7. Global Deterioration Scale of the group involved the first phase

One general conclusion of this first phase was that patients accepted well the robot and participated as much as actively in robotherapy sessions as in the regular sessions without robot. In addition, some preliminary medical results are showed in Figure 8. They have been presented in medical forums and are better explained in [15]. Evaluation showed no significant differences between robotherapy and control groups at baseline. Dementia severity worsened significantly in control but not in the robotherapy group. Neuropsychiatric symptoms and apathy tended to improve after robotherapy in patients with moderate dementia. They are promising, but further research and analysis is required. A serious clinical study about using robots for cognitive therapy in dementia patients was estimated useful and feasible.

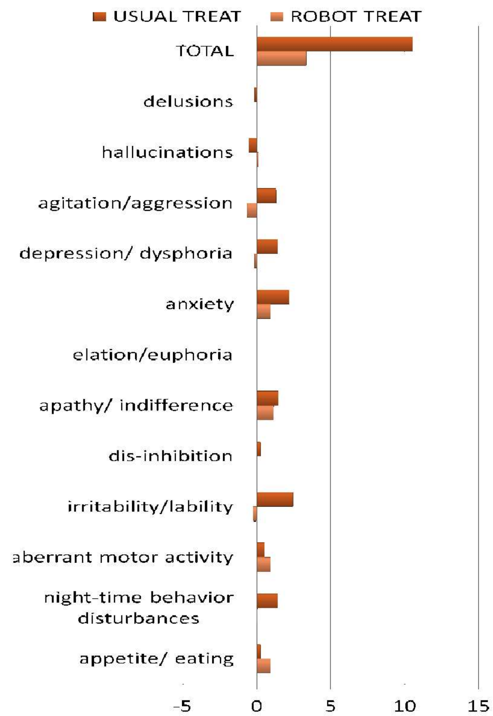

Fig. 8. Some preliminary results of the experiments

The second phase depended on the success of the first phase, and it is now under development. It takes one year and the composition of the groups is different (Figure 9). There are three groups, each one with patients with different degrees of severity of the disease: mild, moderate and severe. The methodology is similar: 30-45 minutes each session and they are being recorded and analyzed. Storytelling sessions were discarded as it became clear that without interaction all patients quickly lost attention in the robot.

The sessions for patients with severe dementia can not be structured as those for people with moderate dementia because they are unable to maintain attention long enough to be effective. For them we designed a set of activities to be carried out by the robot: Walking towards a patient, "looking at" her face, making sounds of animals ... These actions seemed to improve their apathy. Some of these activities (walking towards a patient and "looking at" her face) were also applied during the sessions in the rest of the group, improving their response. To carry out these activities, we extended the software and robotic tools to be easily managed

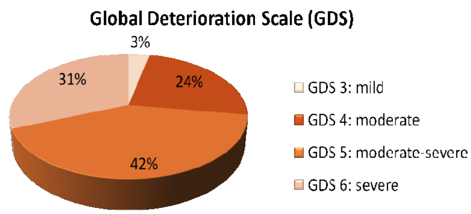

Fig. 9. Global Deterioration Scale of the group involved the second phase

by the therapists. The wiimote extension of the session monitor and the tablet based session monitor have been developed after observing in the experiments the the autonomy needs of the therapists.

V. Conclusions

In this paper we have presented a cutting edge application of humanoid robots in therapy of Alzheimer patients, as a new cognitive stimulation tool. They help to slow down the increasing impairment typical of this kind of dementia.

We have developed several software pieces to support this application. First, our BICA software architecture integrates all robot perceptive and actuation capabilities. Second, a software module helps to visually generate "session scripts". These session scripts are simple descriptions of robot behavior sequence along the therapeutic sessions. They involve the music playing, movements and light generation capabilities onboard the humanoid. They have been created with the knowledge and support of medical experts and are stored in single files. Third, a software module inside BICA runs the session scripts on the real robot. Fourth, a monitor module allows the human therapist to control the script execution, proceeding with the next behavior, repeating steps, etc. and so modulating the session development. Two different monitors have been develped, one running on a regular PC and another one running on an Android tablet. The wiimote device has also been used for easy robot control by the therapists.

Four kind of sessions have been prepared and performed: storytelling, music therapy, physiotherapy and logic-language therapy. In music sessions the robot plays songs from the years when the patients were young, trying to touch their affective and feeling stimulation. In physiotherapy sessions the robot performs several physical exercises with the intention of being repeated by the patients. Logic-language therapy is based on several simple questions to cognitive stimulate the patient responses.

The preliminary medical results on real patients with moderate dementia are promising. Their neurophyschiatric symptoms tend to improve over those of patients following classic therapy methods, but further research is required. Surprisingly the robot captures elder attention due to its human shape, its movements and music capabilities.

We are working on extending the direct interaction between the patients and the humanoid robot. For instance, the real patient showing colored cards to answer to questions done by the humanoid. Also we are programming the robot with more autonomous behaviors like face tracking or people following.

Acknowledgment

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ANEXO II

ANEXO II

En el anexo II se incluyen el resto de convocatorias públicas competitivas, publicaciones y comunicaciones a congresos del proyecto **Roboterapia en demencia**.

CONVOCATORIAS PÚBLICAS COMPETITIVAS

2012	Obtención convocatoria subvención pública competitiva del Ministerio de Educación, Cultura y Ciencia Holandés - Stichting Innovatie Alliantie- Regional Attention and Action for Knowledge circulation (SIA RAAK 2011-3-30int)

PUBLICACIONES

2015	**Valenti-Soler, M.**, M. Heinemann, S. Anisuzzaman, C. Smits, S. D. Vos, A. P. Muñoz, I. R. Pérez, L. C. Chillón, C. M. Rebolledo, C. P. Muñano, V. I. Carretero and M. Heerink (2015). Picking New Friends: Caregivers and Dementia Patients Choices of Robotic Pets. Canadian International Journal of Science and Technology, 2 (May 2015): 354-357.
	Smits, C., S. Anisuzzaman, M. Loerts, **M. Valenti-Soler** and M. Heerink (2015). Towards Practical Guidelines and Recommendations for Using Robotics Pets with Dementia Patients. Canadian International Journal of Social Science and Education, 3 (May 2015): 656-670.
	Heinemann M, **Valenti M**, Heerink M. Is it real? Dealing with an insecure perception of a pet robot in dementia care. Proceedings New Friends 2015 - The 1st International Conference on Social Robots in Therapy and Education Almere The Netherlands
2014	Loerts, Marijke; **Valenti Meritxell**; Heerink, Marcel; Bemelmans, Roger (2014) Knuffelen met nieuwe vrienden - een handreiking voor zorgprofessionals bij de inzet van robotdieren in de zorg voor mensen met dementie Almere: Windesheim Flevoland
2013	M. Heerink, J. Albo-Canals, **M. Valenti-Soler**, P. Martinez-Martin, J. Zondag, C. Smits and S. Anisuzzaman. Exploring requirements and alternative pet robots for robot assisted therapy with older adults with dementia. ICSR 2013: 13th International Conference on Software Reuse
	M. Heerink, J. Albo-Canals, **M. Valenti-Soler** and P. Martinez-Martin, "A kind of snoezelen - requirements for a therapeutic robot for older adults with dementia according to caregivers," 2013 IEEE RO-MAN, Gyeongju, 2013, pp. 680-684. doi: 10.1109/ROMAN.2013.6628391

COMUNICACIONES A CONGRESOS

2014	**Valentí Soler, M.;** Heerink , M ; Mendoza Rebolledo, C; Pérez Muñoz, A.; Rodríguez Pérez, I.; Carrasco Chillón, L.; Osa Ruiz, E.; Felipe Ruiz, S. ; Melcon Borrego, G. ; Espada Raboso, L. ; Albó Canals, J. ; Olazarán Rodríguez, J.; Martínez Martín, P.. Nieuwe Vrienden, Oude Emoties LXVI Reunión anual de la Sociedad Española de Neurología. Barcelona, 2014.

Picking New Friends: Caregivers and Dementia Patients Choices of Robotic Pets

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Abstract. This study explores the possibility of alternative pet robots to be used in dementia care. It describes how both caregivers and dementia patients in Spain and The Netherlands were exposed to alternatives and asked to make a choice for the one they considered most suitable or felt most attracted to. The results indicate that this field would benefit from more diversity and more research upon the specifics of alternative pet robots. It was also established that expectations of caregivers did not entirely match the choices made by their patients and that movements and sounds of robotic pets consistently has influence on affective interaction.

Keywords: robot assisted activity, social robots, multidisciplinary research, triangulation, dementia care

1. Introduction

The use of robotic pets for older adults suffering from dementia has been extensively researched in the last fifteen years and it has been established with both short and long term research that this is a successful form of therapy (Bemelmans, Gelderblom, Jonker, & De Witte, 2012; Inoue, 2012; Wada & Shibata, 2006, 2007). Although most research has been done in Japan (especially by Wada and Shibata) and with the same seal shaped robot called Paro, it is generally assumed it improves mental and physical wellbeing and results in a more active interaction of the subjects with their environment (Broekens, Heerink, & Rosendal, 2009).

Although there have been studies with alternative pet robots (Furuta, Kanoh, Shimizu, Shimizu, & Nakamura, 2012; Kriglstein, 2005; Sherwood, Mintz, & Vomela, 2005; Wada & Shibata, 2007; Wada, Shibata, Musha, & Kimura, 2005), Paro is by far the most widely used robotic pet for this purpose. This could be due to the fact that Paro is not only especially developed for this purpose, but also commercially available. However, acquiring a Paro is quite an investment since it costs close to six thousand dollars (Japantrendshop.com). Eldercare professionals that would like to try working with a robotic pet but have a very limited budget may look for alternatives. These would be pet robots that would meet the requirements that would make them suitable for robot-assisted therapy.

In this study we address these requirements and the possibilities of alternative pets by offering pet choices to professional caregivers working with older adults who suffer from dementia and compare them to the choices that dementia patients make. These caregivers may have experience with similar types of interventions, like using real pet animals (Banks, Willoughby, & Banks, 2008), stuffed animals or other techniques that stimulate the senses for which the term ‘snoezelen’ is used. It is described as a form of Multi-Sensory Stimulation (MSS), and is a widely used and accepted approach to nursing home residents suffering dementia (Spaull, Leach, & Frampton, 1998; Verkaik, van Weert, & Francke, 2005).

In the study we present here, we wanted to establish (1) the acceptability of alternative robots by dementia patients, therapists and care personnel, (2) a possible influence of experience with robotic pets or the above mentioned alternatives and (3) the differences and agreements between preferences for pet robots of caregivers and dementia patients.

FIGURE 1. Paro

In the following section we will specify the background of this study and the research questions of the presented study. After this, we will discuss the used method and the participants. The section that follows on this will feature the results of (a) the study concerning caregivers attitudes and preferences and (b) the preferred choices by dementia patients. Based on this we will draw (preliminary) conclusions and present a discussion, leading to remarks on further research.

2. Choosing robotic pets

2.1. Project framework

The “New friends, old emotions” project is a Dutch-Spanish collaboration which targets the accessibility of robot-assisted therapy for caregivers that work with older adults suffering from dementia. Dutch government funding mainly finances it. Its first aim is to establish the need for guidelines for robot-assisted therapy by caregivers.

Furthermore, it targets an inventory of (1) experiences that some caregivers already have with robotic pets, (2) available pet robots and their suitability for this form of therapy, and (3) practices by caregivers that can be related to this form of therapy (e.g. using stuffed animals, real pets and activities that otherwise stimulate the senses of the subjects). Moreover, it aims to use the findings of these studies to provide guidelines and to offer supportive workshops for robot-assisted therapy.

The consortium that carries out this project, consists of Dutch and Spanish universities that have technical experience with (pet) robots, experience with field studies concerning older adults, or specific expertise in both studying and working with older adults suffering from dementia. Also a part of the consortium is eldercare institutions in different cities of the Netherlands. The project management is carried out by the Robotics research group of Windesheim Flevoland University of Applied Sciences in Almere, the Netherlands.

In earlier studies within this project (Marcel Heerink, Albo-Canals, Valenti-Soler, & Martínez-Martin, 2013; Marcel Heerink, Albo-Canals, Valenti-Soler, Martinez-Martin, et al., 2013), we found that most of the caregivers were familiar with robot-assisted therapy. Moreover, they were generally quite willing to apply it if they did not already do. Remarkably they easily linked this form of therapy to familiar activities, like working with real pets, stuffed animals and evoking emotions by stimulating the senses.

2.2. Research questions

The questions which we would like to have answers to were the following: :

1. Which robot do the caregivers deem the most and least suitable for use in therapy?
2. How do they judge the suitability of a given robot? This was asked on a five step scale
3. How many patients (out of ten) with mild dementia do they expect would like to caress a given robot?
4. Which robots were actually preferred by dementia patients?

3. Method

To enable us to answer the first three questions we noted the reactions of people with dementia to seven different robotic animal s; a dog, a cat, a teddy bear, a seal, a monkey, a penguin and a koala bear. Not only did we observe the reactions to the animals when they did not move or make a sound (when they were switched off) but also when they did move and make sounds. The animals were all of a similar size, approximately 30 centimeters long and all were able to move their arms and heads when touched. When doing this they also made a soft squeaking sound adapted to the natural sound of that type of animal.

FIGURE 2. Available robotic pets

3.1. Participants

In Madrid, twenty care professionals of different age and educational level who attended a course were invited to take part in this research and answer the questionnaire. In the Netherlands, 29 care professionals from different care institutions all over the country were recruited to take part.

In the experiment 58 patients with dementia (GDS 4: 12%, GDS 5: 40%, GDS 6: 38% and GDS 7:10% - see *Table 2*), mean age 84.22 years (range: 68-103years), 78 % women, were included. These patients were beneficiaries from the day care center and the patients who were living in different units of nursing homes.

TABLE 1. Descriptive Statistics Patients Stage of Dementia

		SMMSE			**MMSE**		
Patients	GDS	MEAN	MAX	MIN	Mean	Max	Min
GDS 4	7	28,29	30	0	20,71	28	0
GDS 5	23	23,35	30	0	11,26	15	0
GDS 6	22	15,64	26	0	5,73	17	0
GDS 7	6	5,67	19	0	1,83	9	0

All persons with possible allergies or fear of the robot were discarded as participants in this study.

3.2. Procedure

All dementia patients were divided in groups of 6-9 people with similar dementia severity. Patients were seated round a big table. The robots were introduced in the center of the table and presented as 'new special friends' provided by one of the researchers. The robots were switched off. For a few minutes, patients observed them in a freely way, could touch them and ask questions about them.

Their therapist was the leader of the session and asked every patient if he/she liked the robots in general and one by one; if he/she wanted to work with them in the therapy sessions and if they wanted to repeat the experience. Subsequently, every patient was asked to select only three robots, which he/she liked more in order of preference.

The therapist invited every patient to touch or caress the robots, give a name to the robots and nd finally, if the patient did not talk about it, the therapist asked the patients if the robot seemed real.

After the switched-off phase, the switched-on phase took place. Every phase took approximately 40 minutes. The rest of the researchers took notes about the patients affective behavior and conversational expressiveness (M. Heerink, Kröse, Evers, & Wielinga, 2010), focusing on caress, cuddle, smile, talk to it, hold it tight during the session using the data collection sheets.

4. Results

As *Table 1* shows, the care professionals in the two countries only substantially differed in experience (almost twice as high in the Netherlands).

TABLE 2. Descriptive Statistics Care Professionals

	Spain					Netherlands				
	N	**Min**	**Max**	**Mean**	**Std. Dev.**	**N**	**Min**	**Max**	**Mean**	**Std. Dev.**
Age	20	26	52	38,35	8,768	29	22	63	46,34	9,781
Years in dementia care	20	0	15,0	6,525	4,7336	29	1	45	12,50	9,701
Experience with robots	20	1	5	1,50	1,147	29	1	4	2,00	1,069
Experience with snoezelen	20	1	5	2,05	1,356	29	1	4	2,86	,915
Experience with animals	20	0	3	1,55	,945	29	1	5	2,34	1,111

4.1. Which robot do the caregivers deem the most and least suitable for use in therapy?

The favorites in both countries together is the cat. We found 23 out of 49 people naming the cat as their first choice and another 15 as second choice. Just one person names it in last place. The seal is well liked too: 13 people rank it in first place and 10 in second. No person names it in last place. The dog follows with 9 first and 11 second places, but also ranks last 5 times (*Table 3*).

TABLE 3. First, second and last choice of robots. The first number in each column signifies the total, the second the number in Spain and the third in the Netherlands. The robots are sorted according the first preference in the upper half and last choices in the lower half since differences are more pronounced there.

Robot	First choice	second	last
cat	23, 15, 8	15, 3, 12	1, 0, 1
seal	13, 3, 10	10, 6, 4	0, 0, 0
dog	9, 5, 4	11, 8, 3	5, 1, 4
bear	4, 3, 1	9, 8, 1	8, 0, 8
koala	3, 2, 1	4, 1, 3	6, 4, 2
monkey	5, 2, 3	2, 2, 0	8, 6, 3
penguin	5, 3, 2	2, 1, 1	13, 5, 8

If we sum up first and second places per country we see an even more pronounced preference for the cat in Spain as compared to the Netherlands. For seal and dog the percentages of answers in favor of these robots are more or less the same in both countries.

For the bear we find an interesting difference between the answers in Spain and the Netherlands: whereas it is rather well liked in Spain with 3 first and 8 second places and no extreme dislike, from the Dutch caregivers it gets 1 vote for first and second and 8 for the last place. This means had we only to consider the results from the Netherlands the bear would be at the very bottom of the table.

Koala, penguin and monkey were not popular among Spanish and Dutch caregivers. The penguin is by far least liked. The monkey and koala get a few more dislikes than likes.

To obtain an indication of certainty for the ranking it can be established whether a rank obtained by addition of first and second choice per country gives the same results, or that in fact the total per country is the same. Comparison of these numbers very quickly shows that the absolute place of one robot as compared to the others is difficult to ascertain from this sample. We can, however, with certainty state that cat, seal and dog are well liked, whereas koala, monkey and penguin are less liked. Remarkably, he bear is liked in Spain and disliked in the Netherlands.

4.2. How do the caregivers judge the suitability of a given robot?

When we asked the caregivers whether they deemed a certain robot suitable or not we get the results shown in *Table 4*. The answers certainly and probably suitable were added to up positive, and certainly and probably not suitable were added up to negative.

TABLE 4. Suitability of robots for therapy according to caregivers. The first number in each column signifies the total, the second the number in Spain and the third in the Netherlands, respectively. In the last column we give the difference between positive and negative suitability. The robots are in the same order as in table 1. Note that this more or less coincides with the ranking according to suitability.

robot	positive	undecided	negative	positive -negative
cat	37, 15, 24	7, 2, 5	2, 0, 2	35, 15, 22
seal	32, 12, 20	12, 5, 7	5, 3, 2	27, 9, 18
dog	26, 14, 12	11 4, 7	11, 1, 10	15, 13, 2
bear	19, 11, 8	22, 8, 14	8, 1, 7	11, 10, 1
koala	20, 7, 13	14, 6, 8	14, 6, 8	7, 1, 5
monkey	15, 6, 9	16, 8, 8	16, 4, 12	-1, 2, -3
penguin	12, 7, 5	14, 5, 9	22, 7, 15	-10, 0, -10

The cat is considered suitable by more than 80% of the valid answers in both countries. Only in the Netherlands we find two people who think it might probably not be suitable. Seal and dog rank high, too.

When we have a look at the net suitability defined as the difference between the number of caregivers who find a robot suitable minus the number who find the same robot unsuitable we get see some interesting details: the cat is deemed the most suitable in both countries, the seal is a close second only in the Netherlands, while in Spain the dog is a close second and seal and bear are nearly equal on third place. Dog and bear are not considered as suitable in the Netherlands.

4.3. How many dementia patients do the caregivers expect would like to caress a given robot?

Table 5 shows the cumulated answers to this question. The second column tells us how many caregivers expect more than half the patients would like to cuddle or caress a certain robot. The next column gives the number of less optimistic caregivers: they expect half or less of the patients would like to touch the robot.

When we look at the last column we can directly see which group is prominent. There are only two robots for which a very optimistic expectation exists: the cat and the seal. Note that the cat again is viewed more positively in Spain as compared to the Netherlands. For the seal the picture is more comparable in both countries. For the group in the less optimistic regime, with a negative difference, there is only one that is expected to have a similar response by the patients for both countries, namely the dog. For all other types the numbers for Spain and the Netherlands strongly differ.

TABLE 5. How many patients (out of ten) would like to caress a given robot according to caregivers? We give the sums for a more positive expectation in the second column, a less positive expectation in the second column and the difference of the two in the last column. The first number in each column signifies the total, the second the number in Spain and the third in the Netherlands, respectively. The robots are in the same order as in table 1. Note that this more or less coincides with the ranking according to the positive expectation sum for both countries.

robot	6 to 10 patients	1 to 5 patients	difference
cat	26, 12, 14	19, 4, 15	7, 8, -1
seal	24, 10, 14	20, 7, 13	4, 3, 1
dog	18, 7, 11	25, 9, 16	-7, -2, -5
bear	19, 11, 8	26, 6, 20	-7, 5, -12
koala	14, 2, 12	29, 15, 14	-15, -13, -2
monkey	13, 7, 6	25, 7, 18	-12, 0, -12
penguin	9, 5, 4	36, 11, 25	-27, -6, -21

The main overall observation is that the Spanish caregivers have a higher general expectation for the robots. Whereas from the answers of the Dutch caregivers we see the only positive difference for the seal and small negative numbers for cat and koala, the Spanish respondents were positive for cat and seal, and a little less optimistic for dog and monkey.

The results for the monkey have to be taken with a grain of salt since a significant number of respondents did not give an answer for it (4 out of 20 in Spain and 5 out of 29 in the Netherlands).

In summary, we observe distinct differences in perceived suitability and expected patient response for the different robots. The ranking of robots in answer to different questions is consistent and stable. Of the robots used in this study cat, seal and dog were expected the most suitable, likable and likely to be used and accepted by the patients.

There appear to be some differences in the manner different types of animals are perceived in Spain and the Netherlands. But we would like to be very cautious at this stage and not read too much into this finding: the sample size is too small to rule out personal preferences. Further examination of this effect is certainly warranted in order to assess the transferability of research of this kind from one country to another.

The expected patient behavior for Spain can be compared to the ranking of the robots by patients. When switched off 25 out of 58 patients declared the cat to be their favorite. When switched on this number increased to 27 out of 58. The following place could not be decided from the patients answers since the number of patients who did not answer by far outweighed the number of valid votes for any type of robot. For first place no response had only been 10 and 14 out of 58.

This shows very clearly that patients and caregivers agree in their first choice.

4.4. Dementia patients: preferences and affective behavior

The dementia patients were generally cooperative, but most of them did not make a second or third choice, mostly because they stuck to their first choice or because they reported they just couldn't choose. The first choice however, was generally made within seconds with the robotic animals switched off, except for ten participants.

After switching them on, the participants took their time to watch and listen and fourteen of them could not make a choice. In both cases, the cat scored by far the most preferential picks, although it is still not everyone's favorite. Remarkable is that the seal was not chosen when the animals were switched on.

Also remarkable is that the bear was not chosen less. While in an earlier study (Heerink et al. 2013), we used a teddy bear with dementia patients and saw them switch away when it started to move. An explanation could be that the bear in the present study has a shape that is less that of a classic teddy bear and thus it is less estranging to see it come alive.

TABLE 6. First choice of animals by dementia patients in a switched *Off* and switched *On* state.

	Off		**On**	
	Frequency	**Percent**	**Frequency**	**Percent**
no answer	10	17,2	14	24,1
koala	2	3,4	2	3,4
bear	5	8,6	6	10,3
penguin	2	3,4	1	1,7
dog	7	12,1	3	5,2
monkey	2	3,4	4	6,9
seal	5	8,6	0	0
cat	25	43,1	27	46,6

As Figure 3 shows, the cat also scored the highest on affective behavior, although differences are less extreme. Especially the monkey scores a relatively high number of affective behavioral ques. If we compare these preferences to the predictions that care professionals gave, we see that the extremes of the pattern is roughly the same (cat is favorite, penguin least favorite), although in details there are differences (monkey and bear score better than anticipated).

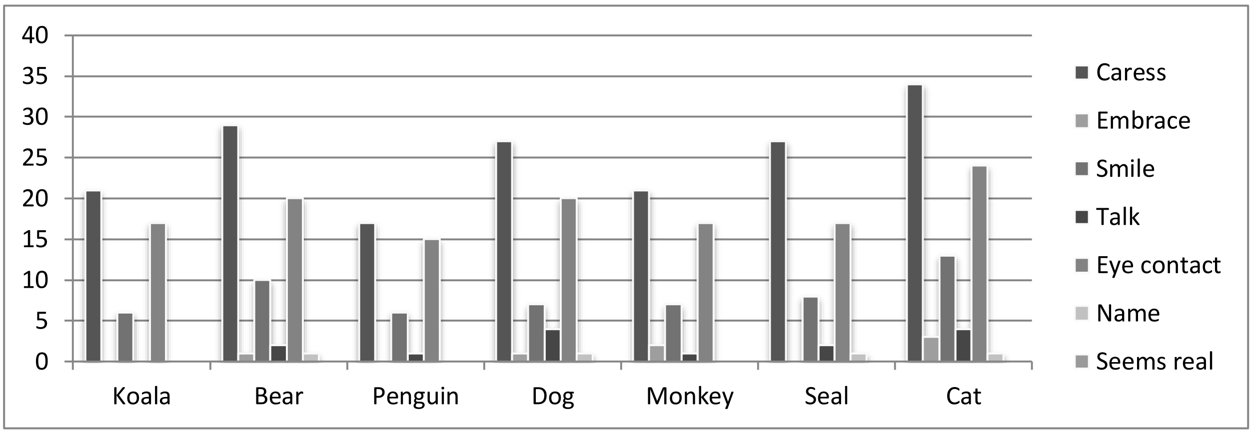

FIGURE 3. Observed affective behavior of dementia patients with robot switched off.

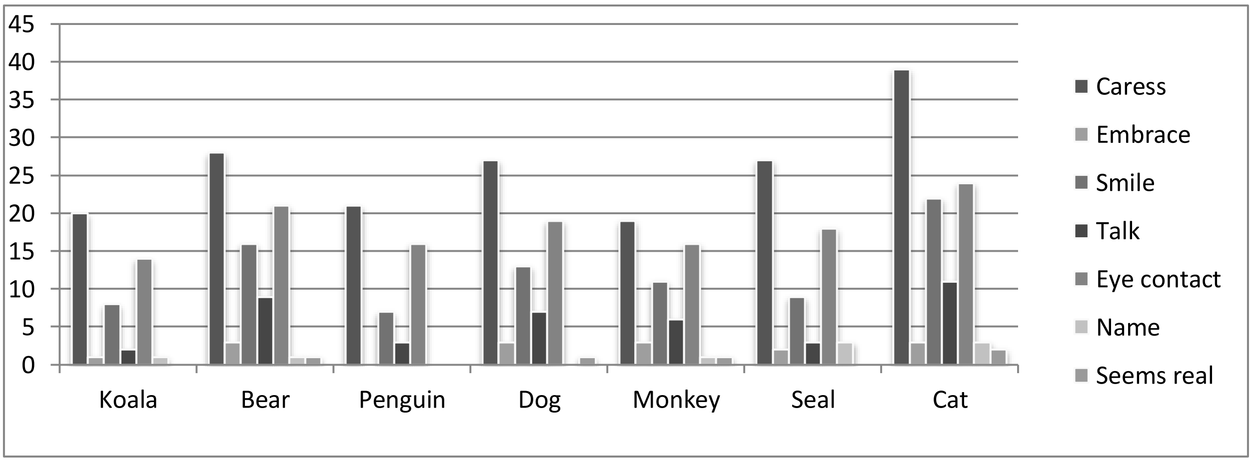

FIGURE 4. Observed affective behavior of dementia patients with robot switched off.

When we compare the scores for observed affective behavior between the *Off* and *On* state (*Table 7*), we can also see that consecutively all of these behaviors on each of the robots scored higher for the *On* state.

TABLE 7. Results of a paired T-test, comparing observed affective behavior of dementia patients in *Of* and *On* states of the presented pet robots

		Mean	**Std. Deviation**	**t**	**Sig. (2-tailed)**
Pair 1	Koala Off - Koala On	-,286	1,799	-,420	,689
Pair 2	Bear Off - Bear On	-2,286	3,039	-1,990	,094
Pair 3	Penguin Off - Penguin On	-1,143	1,464	-2,066	,084
Pair 4	Dog Off - Dog On	-1,429	2,507	-1,508	,182
Pair 5	Monkey Off - Monkey On	-1,286	2,498	-1,362	,222
Pair 6	Seal Off - Seal On	-1,000	,816	-3,240	,018*
Pair 7	Cat Off - Cat On	-3,571	3,505	-2,696	,036*

5. Conclusions, discussion and further research

The interest in the seal by dementia patients and its suitability as presumed by caregivers was not not greater than that in the dog or cat. The cat actually was more favored by caregivers and preferred by about half of the patients. The interest in the other robots was comparable and in an *On* state even greater than it was for the seal.

Our conclusion is that the seal is not always the most suitable form and conversations with care professionals confirmed this. Many of them seemed to have experience with cheap robots from the toyshop. Sometimes this was due to a limited budget: seal Paro cost around € 6,000, compared to the cost of a robotic animal from the toy shop at around € 50. They noticed that for many of the activities these cheap animals were effective enough, sometimes even more so due to the fact that they were much less heavy than Paro. It is however important to note that, unlike Paro, these robots have not been designed or manufactured to be used in therapy. They are not prepared for their use in groups and less for their use by people suffering from dementia

Furthermore we noticed strong personal preferences; people who hardly reacted to the seal often reacted much more positively to a cat or a dog. Even others reacted more strongly to a monkey or a koala bear. A therapist expressed that she realized she actually needed a box full of animals to be able to work with all the people in her group.

Regarding the differences between the care professionals we noticed that in general there were a lot of similarities. Where there were differences, we could not attribute them to a country, education or experience. What we can say is that volunteer caregivers who have a partner with dementia have less need for guidelines. They wanted to find out for themselves what worked for their partner since they had personal background knowledge of their husband or wife.

Considering the types of robotic pets we have used, we have to note that we cannot derive conclusive statements from the preferences other than that they differed. The presented robots differed in more than one aspect (color, sound, shape,…) and for each animal different specific choices could have led to different results (i.e. a gorilla instead of a chimpanzee, a brown seal instead of a white one, a bulldog instead of a Labrador like dog). Further research could focus on these choices and establish more detailed requirements and preferable specifications. Moreover, it could explore different settings , for example by having multiple sessions with a smaller number of robots in each session as we experienced that many participants who suffered from moderate and severe dementia found it difficult to keep attention and required multiple breaks throughout the experience.

But most of all, further research should focus on the development of alternative robotic pets, to encounter the personal differences of dementia patients and enable care professionals to offer each of them the robot that generates the most and strongest beneficial effects.

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Towards Practical Guidelines and Recommendations for Using Robotics Pets with Dementia Patients

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Abstract. This paper describes a path to practical guidelines for professional caregivers and family members who want to use pet robots in the care for persons with dementia. It reports how a literature study, which included the use of related techniques, was combined with interviews with professional caregivers and field studies. The result of this triangle approach is an outline of directives and recommendations, represented in a practical set of guidelines.

Keywords: robot assisted activity, social robots, multidisciplinary research, triangulation, dementia care

1. Introduction

The general goal of using pet robots in the care of people with dementia is to increase their feeling of health and wellbeing, and to decrease anxiety. They stimulate them to be more communicative and enable caregivers and family members to make contact with them - they calm down or indeed revitalize, are less anxious and/or confused, feel less lonely and/or depressed, are happier and laugh more, remember earlier times (reminisce)and communicate more and better with their surroundings (Bemelmans et al. 2012, Broekens et al. 2009)

But how are these effects reached? How to use the robot? For which clients are pet robots suitable or and for which ones not? What do you have to watch out for? How to work with groups of people or an individual client? When and how do you involve relatives ? These are a few of the many questions care professionals, volunteer caregivers and family members who (want to) work with pet robots have (Heerink, 2012). There is a need for information and practical guidelines when using pet robots in the care of people with dementia (Heerink et al. 2013a).

To meet this need the project “New friends, old emotions” was initiated at the end of 2012. In this project Windesheim University and Zuyd University together with professionals from 6 participating care centers for the elderly and with the Spanish knowledge partners LaSalle Ramon Llull University” and the CIEN Alzheimer Foundation of the Carlos III Institute for Health, carried out practice oriented research into the use of various robotic animals(1) in individual patients and in groups, (2) in various stages of dementia (3) in cooperation with professional caregivers, relatives and volunteers and give as many ‘evidence based’ answers as possible to the questions listed above. The findings were to be translated into a set of guidelines and recommendations for the use of pet robots in dementia, to be disseminated in a practical handbook, a series of workshops for care professionals and academic publications.

Our main research question was: *How can professionals in the care of older people with dementia work effectively with robotic animals?*

By "effectively" we mean that there is a positive effect on the quality of life. In addition, we engage both the perceived quality as the objective effects observed. With this in mind, we aimed to answer the following questions:

1. What care-related requirements and preconditions for working with robotic animals emerge from literature and experiences of care professionals?
2. To what extent can different types available robotic animals be applied?
3. What factors support the therapeutic use of a robotic animal in this context?
4. What practical evidence-based guidelines for working with robotic animals in the care of older people with dementia, can be derived from literature, new knowledge from field research and the experiences of professionals?

In the following sections we will describe how we developed these guidelines and recommendations based on a triangulation research setup and give an impression of the developed guidelines.

2. Method

An obvious approach to gather knowledge is literature search. However, as we will discuss in section 3, much research has been done to describe the effects of robot assisted therapy, but there are very little detailed descriptions of therapeutic approaches. We therefore expanded our search to related techniques. Furthermore, we collected data from field experiments (trials) and gathered experiences of professionals who had worked with robotic pets.

The developed guidelines were primarily published in a book (originally in Dutch, but currently translated into English and Spanish). Besides this, we developed practical workshops in which caregivers are able to experience and exercise working with robotic pets.

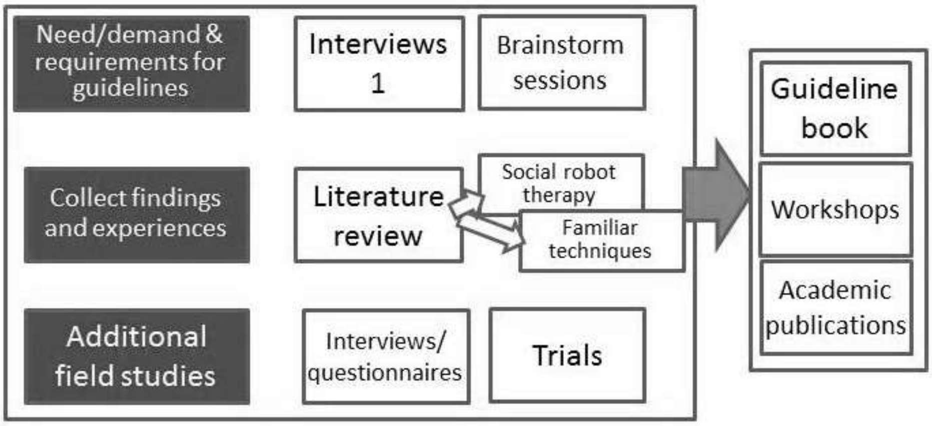

FIGURE 1. Reseach strategy

3. Related research literature

For over a decade pet robots have been used in the care of older adults with a wide variety of problems. Various studies have shown that pet robots have a positive effect on the health and well-being of people suffering from dementia, by stimulating the senses, decreasing anxiety and stimulating interaction (Bemelmans et al. 2012, Broekens et al. 2009). A large number of these studies concerns the use of Paro, a seal robot, which was carried out in Japan. This especially takes into consideration the experiments which took place in a care home or a daily activity center for the elderly (Shibata , 2004-2005; Wada, 2005-2008; Wada & Shibata, 2007). There was only a limited translation into practice made during and after these studies on the effect of robot therapy and no indications on how these effects can best be realized or optimized by caregivers. As a result of this shortage, research was performed into the existing literature in the following areas:1) the experience of users of pet robots (care professionals, persons with dementia and volunteers working with them) 2) existing manuals and guidelines for similar interventions such as sensory sessions, therapies with dolls/cuddly toys and therapies with (domestic) animals.

The first literature study (February – March 2013) derived information based on experiences of the professional caregivers, patients and volunteers when using pet robots. The search regarded international literature of therapies and activities with pet robots in the care for persons with dementia, the care for handicapped persons and mental healthcare. Databases that were used were Cinahl, Pubmed Cochrane Library, PsycINFO, Picarta and Google Scholar, on robots, robotic(s), robot assisted, in combination with socially assistive, therapy, activity, intervention, animal, pet, social, companion, therapy, activity, elderly, older adults, dementia and in the second stage with scent, aroma, sound, music, tone, practice, guidelines, recommendations, snoezelen, multi-sensory, toy and dolls.

The initial result of 661 references was filtered on double appearances and relevance as indicated in titles and abstracts, which resulted in a selection of 110. After these were analyzed for indications for guidelines and recommendations, a final list of 23 articles was created. A total of eighteen articles concerned robot therapy with Paro. Five described the use of robot cats NeCoRo and Cleo (Libin & Libin 2003, 2005), robot dog AIBO (Banks et al. 2008) and the Nabaztag (Klamer & Ben Allouch 2010), a communication robot in the shape of a rabbit.

3.1. Type of robot

Most studies concerned robot therapies with Paro, the ‘seal robot’. All cases focused on activities with polder adults. Other articles described activities with robot cats NeCoRo and Cleo(Libin & Libin 2003, 2005), robot dog AIBO (Banks et al. 2008) and the Nabaztag (Klamer & Ben Allouch 2010), a communications robot in the shape of a rabbit.

3.2. Reported experiences of care professionals

When the opinion and experiences of professional caregivers is mentioned we refer to staff working in a residence for older people and people with dementia. Their experiences were in general of a positive nature, observing positive changes in behavior during and after interaction with the robot. They especially noticed positive effects on the communication and interaction between themselves and the people they care for and also between the elderly people (Banks et al. 2008, Calo et al. 2001, Pedersen 2011, Robinson et al. 2013).

The robot offers opportunities for the caregivers and clients to talk with each other about the the appearance, movements and reactions of robot, its appearance and its movements and reactions. It was also observed that the residents became more active and happier through contact with the robot. The general picture of the experiences of the care professionals shows that robot therapy improves the general wellbeing of the client and creates a better atmosphere. In the more discerning experiences of the care professionals it is noted that pet robots are not suitable for every dementia patient. Some elderly people are afraid of the robot or due to some other reason do not want to take part in the activities with the robot, e.g. because they do not like animals or because they become agitated by the sound of the robot.

Also some caregivers question whether the elderly people are stigmatized when allowed to “play” with a robot. They have the idea that the elderly people would be made to look like fools because they find it difficult to differentiate between a robot and a living animal when approaching it. Also mentioned is the need for guidelines and methodology for using pet robots by caregivers.

The professionals do not often know how to handle the robot exactly or how to use it to an advantage for the care of their clients.

Experiences of informal caregivers: it has been highlighted in the literature that the children of parents with dementia find they are able to communicate more easily with their parents thanks to the robot. They see that it helps their parent(s) in expressing their emotions and feelings. They see that their parents laugh more and have fewer problems with loneliness. Just like the care professionals the informal caregivers think that the robot is less suitable for people who do not like animals or cuddling . Furthermore they also experience the need for guidelines when offering the pet robot (Shibata et al, 2005; Wada et al, 2002, Weingartz, 2011).

3.3. Reported clients experiences

In general the experiences of clients with pet robots are positive, finding it is nice to make contact with the robot. They become contented and feel less lonely when the robot is close, encouraging them to talk. The robot causes clients and visitors to sit closer together and to talk to each other (Calo et al 2001, Kidd et al. 2006, Klamer & Ben Alouch 2011, Libin & Libin 2003, 2005, Robinson et al. 2013, Roger et al. 2013)

The elderly in a care home or a nursing home notice that the atmosphere in the group is better when the robot (Paro) is present. In some cases the clients rename the robot or sing songs for him. Women in particular treat the robot as if it is a (small) child/baby. Men are often more interested in the technical side of things, and want to know how the robot works. There are also clients who don't want to do anything with the robot because it is not a real animal or they are afraid of. Others. especially male clients. think it is childish or effeminate to play with such a cuddly toy or they find it boring because the robot cannot talk.

3.4. Reported experiences with related interventions

Therapy or activities with pet robots share some characteristics with more familiar interventions, such as sensory therapy and therapy with real (domestic) animals, or with dolls and cuddly toys. The most important similarity is that all these interventions, just like robot therapy are aimed at stimulating the senses and decreasing anxiety (Powell 2012, Klages 2011, Verkaik et al. 2005). Because these interventions exist and have been implemented over a longer period of time , manuals and a professional methodology may have already been developed. This is the reason why the existing literature was looked into for guidelines for these interventions.

The following related interventions resulted from the literature analyses.

- *Snoezelen*, or *sensory therapy* is an activity designed to stimulate the senses, and that is why it is sometimes called sensory activation. Sensory therapy is designed to positively stimulate the senses. We define Sensory therapy as a method directed at the active stimulation of the senses, hearing, touch, sight and smell, in a client friendly and trusted environment. (Verkaik et al. 2005).

- *Therapy with dolls and cuddly toys,* in this case non mechanical dolls and cuddly toys are used in the care of people with dementia.
- *Therapy with animals*, also known as *animal assisted therapy*, has been applied in the treatment and guidance of a range of target groups for several decades. This term is applies to all types of animal therapy. The use of (domestic) animals, such as cats dogs rabbits horses and dolphins frequently occurs (Powell 2012).

When researching into the (international) literature on these related interventions many articles and studies were found regarding the effects and application of sensory therapy. No useful literature was found on the use of therapy with dolls. There was also little found on therapy with domestic animals. The results of the related interventions which are described here come mainly from the studies which were directed at sensory therapy as a therapy or activity for elderly people with dementia.

It appears from the literature that sensory therapy has similar positive effects to those which are achieved when using pet robots: it is able to produce improved wellbeing and behavior in people with dementia. This means that people with dementia during and/or after participation in a sensory therapy activity show more happiness are more active and have more interaction and communication with their surroundings. Furthermore sensory therapy can result in less apathy and agitation in people.

The possible effects of animal assisted therapy are similar to those of sensory therapy and robot therapy. This allows people with dementia who have had animal assisted therapy to possibly become less apathetic and agitated in their behavior. In addition it could calm the people with dementia down resulting in them showing an improvement in social behavior, demonstrated by more laughing and talking and more interaction with their surroundings. In short, just like robot therapy related interventions such as sensory therapy and animal assisted therapy can be effective especially in the communication and interaction between clients.

Looking for guidelines and recommendations in literature on snoezelen, we first of all found that snoezelen, sensory therapy and multisensory stimulation are one and the same which is usually offered in a defined method. The activity takes place in most cases in a separate space which is specially designed for the purpose of sensory activities. This means that the space is designed with amongst other things various colored lamps, mirrors, music and perfumed oils (Pinkney, 1997). A sensory therapy session is generally of an individual nature (one to one guidance) and takes on average half an hour.

A sensory therapy session is usually guided by a member of staff who is specially trained in the application of the sensory therapy method.

In literature on animal assisted therapy we found very little practical directives, since it has a less predefined way of applying the therapy compared to sensory therapy. Most of the time it takes the form of visiting dogs or cats which for a certain time are allowed into the living quarters or communal areas of the participants. This could take place on an individual basis or in a group session. The animals are usually accompanied by their owners or trainers. This could be a care professional from the institution, but is more often someone from outside the institution who is not specifically trained to work with the animal and the inhabitants of the institution.

Guidelines for sensory therapy were most commonly found in the literature, sometimes in the form of a manual. This overview was laid alongside the above description of the experiences with pet robots.

3.5. Results from additional studies

Within the project field studies in the form of trials were undertaken with people with dementia and supplemented by interviews with care professionals in Spain and the Netherlands (Heerink. 2013 a en b, Heerink 2014, Valenti-Soler 2015). In these studies we wanted to (a) establish the preference for and reactions to *different types* of animals by caregivers and dementia patients, (b) collect additional experiences of care professionals with robotic pet.

To enable us to answer the first two questions we observed the reactions of people with dementia in field studies, in April 2013 and June and July 2014, using seven different robotic animals: a dog, a cat, a teddy bear, a seal, a monkey, a penguin and a koala bear. The animals were all of a similar size, approximately 30 centimeters long, and all were able to move their arms and heads when touched. When doing this, they also made a soft squeaking sound adapted to the natural sound of that type of animal. The reactions to the pet robot by people with dementia were observed in two conditions: when the pet robot did not move or make a sound (switched off) and when they did move and make sounds.

The interest in the seal did not seem to be greater than that in the dog or cat. The interest in the monkey and koala was marginally less. The penguin hardly scored at all and the teddy bear was just the same as that in the seal, cat, and dog.

Our conclusion that the seal was not always the most suitable form was confirmed by the professional care givers. Many of them seemed to have experience with cheap robots from the toyshop. Sometimes this was due to a limited budget: seal Paro cost around € 6,000, compared to the cost of a robotic animal from the toy shop at around € 50. They noticed that for many of the activities these cheap animals were effective enough, sometimes even more so due to the fact that they were much less heavy than Paro.

Furthermore we noticed strong personal preferences; people who hardly reacted to the seal often reacted much more positively to a cat or a dog. Others reacted even more strongly to a monkey or a koala bear. A therapist in Madrid called us when she realized she actually needed a whole box full of animals to be able to work with all the people in her group.

4. Examples of Derived Practical Guidelines and Recommendations

In this section we will give a few directions for the application of the robotic animal s which are on sale at the moment. It goes without saying that both manufacturers of care aids and toy manufacturers will be working on new animals.

4.1. Usable robotic animals

There are robots which have been especially developed for people with dementia such as Paro, which costs around € 6,000 and JustoCat, which costs around € 1.450. Both robots are quite heavy (almost 3 kilos). Paro is without a doubt the most sophisticated, with five sensor types including advanced touch recognition, recognition of light and dark and even daily routine, identifying sound direction, recognizing its name, adjusting to remembered interaction and accurate emotion expression.

JustoCat is a little more simple: he feels when he is being stroked and petted, and therefore purrs, is warm, you can feel him shudder when he purrs. One advantage is that the fur coat is removable to enable washing. Unfortunately that is not possible by Paro.

In addition to these, toy animals are often used, like the *Wowwee Alive* series, in which a seal can be found, and the *Furreal Friends* manufactured by Hasbro. Especially the cat 'Lulu' is often used. Most of these toys will cost between € 40,- and € 60,-.

The toy animals are easy to use especially in group activities, when several robotic animal s are used simultaneously. They will not have the same impact as Paro and JustoCat, due to the fact that they are so light and make more mechanical sounds. The "Feeling of a toy" that springs to mind by the user is strengthened by the fact that there is an on/off switch under the cat's fur which can be pulled or zipped open. The correct switch is not always easy to find there.

Unfortunately toy animals usually are only available for just a few years in the toy trade. However, there is a plentiful supply via Internet trading sites such as EBay.

Pet robots do not always have the desired effect on everybody. It is difficult to point out which person is or is not suitable for the introduction of a robot. Pet robots are in principle suitable for everybody, as long as it matches the needs and wishes of the individual. In practice this calls for insight into the person and situation from the professional caregiver.

Based on practical experiences it seems that pet robots have most effect on people:

- In the later stages of dementia (phase 3);
- Who have or have had (domestic) animals themselves;
- Who have difficulty with making contact

The robot can be used in moments of unrest, sadness, aggression: to calm down the clients, in moments of inactivity: if wished to stimulate the clients. The robots can also be used as an aid to make contact with the clients should they have become introvert.
When family or visitors come round they may use the robot to stimulate the client, reduce tension, to improve the atmosphere, to provide a stable situation and/or as a means of contact.

4.2. Directives and recommendations for activities

A few possible methods of working with the pet robots will now be given. After drawing attention to several points for attention we will give an example of the method of working by a group activity and an activity with an individual client in two different situations: the stimulation of a client and the prevention of unrest by a certain care procedure.

Establishing suitability for the client

Pet robots do not always have the desired effect on everybody. It is difficult to point out which person is or is not suitable for the introduction of a robot. Pet robots are in principle suitable for everybody, as long as it matches the needs and wishes of the client. In practice this calls for insight into the person and situation from the care professional.

Based on practical experiences it seems that pet robots have **the most effect** on people:

- In the later stages of dementia (phase 3);
- Who have or have had (domestic) animals themselves;
- Who have difficulty with human contact.

It is important not to leave the client alone with the robot. This is to prevent any escalation of or negative effects. The client’s feelings and emotions may run high during the activity with the pet robot. It is therefore important that there is always someone close by to guide and support the client when using the pet robot

Knowledge, skills and policy

It is important for the care professional to know how the robot works and how it could/ should be applied in practice. This is to ensure the safety and most effective way of using the robot during the activity . Furthermore, as mentioned earlier , the knowledge and experience with the target group, of the care professional is indispensable when working with the pet robots. When and how to use the robot depends greatly on the insight of the care professional.

It is recommended that a protocol be set up for the use of the pet robot within the care institution, so that professionals all use the same method.

Preparation of activities

It is recommended to offer the robot to the client in a safe and trusted environment. In most cases this will be their own room or a communal living room which is the most suitable.

It is recommended to keep the pet robot in the same place all the time. It will depend on the client(s) and/or residents of the care home which option is the best. The robot can:

- Remain In view of the client(s), e.g. in a cage or a basket. It is possible to choose free access (clients are allowed to pick up the robot whenever they wish) or access at specific times or when the client(s) request it.
- Remain out of view of the client(s), e.g. in a cupboard or in the staffroom.
- In moments of unrest, sadness, aggression: to calm down the clients.
- In moments of inactivity: if wished to stimulate the clients.
- As an aid to make contact with the clients should they have become introvert.
- When family or visitors come round : to stimulate the client, reduce tension, to improve the atmosphere, to provide a stable situation and/or as a means of contact.

In general in is recommended to let the activity last no longer than 20 minutes. Of course the durations depends on the person and the situation. It is important to be aware of overstimulation of the client due to the sometimes unexpected emotions and behavior caused by contact with the robot.

There are many ways in which the pet robots can be applied. Here once again the most suitable way depends on the person and the situation. The advice would be to experiment with this. See what works for which client and in which situation and keep a report of this. A few examples of more specific methods of working will be given In the next paragraph .

Points of attention

Attention should be paid to the following points before during and/or after the activity:

- Take care that the robot is fully charged. Clients may become confused or emotional if the robot breaks down during an activity.

- Remain with the client during contact with the robot in order to guide and counsel the client should feelings and emotions arise.
- Remain in contact (talk with and/or touch) the client and robot during the activity.
- Robot or living being? Allow the client to decide whether or not the robot is treated as a robot, cuddly toy or a real animal. If the client asks what is it, reply for example with “What do you think it is?”. This will enable the perception of the client of their surroundings to be adhered to as closely as possible.
- Evaluate the activity(possibly with the client) and report about it so that this can be taken into account during the following contact moment with the pet robot.
- Give the robot (possibly together with the client) a name or use the type of animal (e.g. seal, cat or dog).

Groups and individuals

Both working in a group and individually are possible. The advantage of working with an individual client is that the care professional can more easily adjust the activity to the needs of that client or situation. While working with groups it has been noticed that some clients have difficulty in “sharing” the robot, therefore that they do not want to give him to another person. Experience teaches us that offering the robot in a group has a positive effect especially on the communication and interaction within the group and thus improving the atmosphere in it.

A few recommendations for group activities:

- Introduce the pet robot to the group by saying for example: “Look what I’ve got here”
- Lay the robot in the middle of the group and then watch and wait to see what the reactions are.
- Describe the robot : say what he likes, what he looks like and what he does.
- Talk to the robot yourself and stroke the animal.
- Ask the participants if they would like to stroke or hold the robot.
- Possibly introduce the robot again when you lay him in the lap of a client.
- Ask the participants what they think of the robot.
- Say good bye to the robot together by saying for example : “The seal is going back in his basket now to sleep” or “See you again next time seal”.
- Allow each participant to say good bye in his/her own manner.

Stimulation of an individual client

- Introduce the robot by saying for example “look Mr/Mrs …., This is a seal, he is coming to sit with you for a while. You can pick him up or you can leave him on the table”

- Lay the pet robot down during the activity so that the client is able to touch him whenever he/she wishes.
- Keep reminding the client that the pet robot is there.
- Describe the robot: what he does, what he looks like and what he likes.
- Talk to the robot yourself and stroke the animal in order to encourage the client to do the same.
- Ask the client what he/she thinks of the robot.
- At the end of the activity, say good bye to the pet robot together by saying for example "Seal see you next time. Would you like to say something to the seal Mr/Mrs………?

Prevention of agitation during the care activity

- Introduce the pet robot before the care activity takes place. For example by saying : Look Mr/Mrs .. , this is a seal, today he is going to ..(go to the toilet) with you".
- Make sure that the client is able to touch the pet robot during the care activity, by for example sitting him on a stool next to the client.
- Do not just talk to the client but also talk to the robot as well. Remind the client that the robot is there. Talk about the robot and involve him in the activity in order to distract the client, if necessary.
- Say goodbye to the robot together at the end of the activity.

5. Conclusion and further research

In this paper we demonstrated how practical guidelines can be developed using an iterative, stepwise approach: literature, interviews and questionnaires, and field studies. However, we have to note that his quest for guidelines and the subsequent approach was motivated by the urgent need for guidelines as expressed by care professionals and subsequently the study was in many aspects explorative and limited in numbers and scale. Moreover, the results can only be *called evidence* based if we accept a broad definition of this term. This means many findings can be found acceptable for practice, but there is still a lack of clinical studies, involving different types of robotic pets, used in dementia care. Nevertheless, it is the first study to focus on the translation of research into practical guidelines for the use of pet robots in the care of persons with dementia which uses this approach.

Moreover, this project shows the value of experiences of professional caregviers that go far beyond the directives and indications that can be derived from present research literature. We found that this concerns not only experiences and developed practices with pet robots, but also with related practices, like working with animals and applying sensory therapy.

Thus, if thoroughly explored and developed into sound hypotheses, the findings in the project "New Friends, Old Emotions" can be the bases of future theoretical and empirical research.

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Is it real? Dealing with an insecure perception of a pet robot in dementia care

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Abstract. When asked by dementia patients whether a pet robot is real, caregivers face the dilemma as to what the best answer is. We asked Dutch and Spanish caregivers what they consider the best answer and find that most would leave the choice to the patients. There appear to be fundamental differences between the answers in both countries: Dutch respondents often compared the pet robot to a real animal while this option was not chosen at all in Spain.

Keywords: robot assisted activity, social robots, multidisciplinary research, triangulation, dementia care

INTRODUCTION

In general, and gradually more commonly, pet robots in the care of people with dementia are used to increase their feeling of health and wellbeing, and to decrease anxiety. They stimulate patients to be more communicative and enable caregivers and family members to make contact with them - they calm down or indeed revitalize, are less anxious and/or confused, feel less lonely and/or depressed, are happier and laugh more, remember earlier times (reminisce)and communicate more and better with their surroundings [1, 2]

But how are these effects reached? How to use the robot? For which clients are pet robots suitable or and for which ones not? What do you have to watch out for? How to work with groups of people or an individual client? When and how do you involve relatives ? These are a few of the many questions care professionals, volunteer caregivers and family members who (want to) work with pet robots have. There is a need for information and practical guidelines when using pet robots in the care of people with dementia [3].

To meet this need the project “New friends, old emotions” was initiated at the end of 2012. This project focussed on practice oriented research into the use of various robotic animals(1) in individual patients and in groups, (2) in various stages of dementia (3) in cooperation with professional caregivers, relatives and volunteers and give as many ‘evidence based’ answers as possible to the questions listed above. The findings were to be translated into a set of guidelines and recommendations for the use of pet robots in dementia care.

IS IT REAL?

During a pilot study within this project, we observed an observation of a woman with severe dementia cuddling a robotic cat, obviously enjoying it. After while, she stopped, seemed confused, and looked up to the caregiver, asking ‘Is it real?’

This is an illustrative case of practice with a challenge: dementia caregivers usually go with a patient’s point of view. But what if this point of view is insecure? This could specifically occur when using life like robotic pets and we wanted to know what the best strategy would be.

We decided to incorporate this case as a multiple choice question in a larger questionnaire [4] on the attitude of dementia caregivers towards therapy with robotic pets.

In Madrid, twenty care professionals of different age and educational level who attended a course were invited to take part in this research and answer the questionnaire. In the Netherlands, 29 care professionals from different care institutions all over the country were recruited to take part.

RESULTS AND DISCUSSION

When looking at the cumulative frequencies for the different answers we see that only a minority would answer “no, it is not real” (12%) , the single most common answer is “what do you believe?” (35%), and the majority of caregivers favor a positive answer (53%).

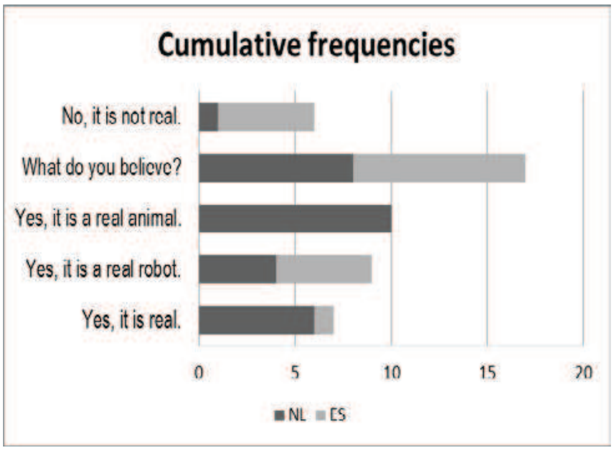
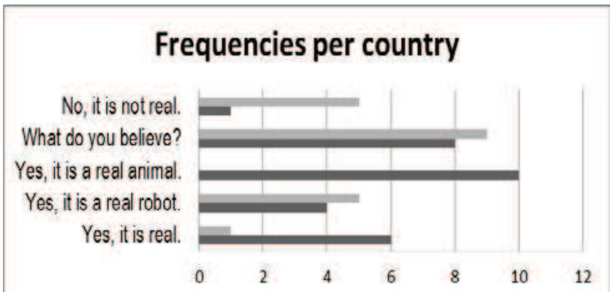


Figure 1. Cumulative frequencies of the different answers. Grey signifies the Spanish and black the Dutch caregivers

However, a closer look at the answers given in Spain and the Netherlands separately presents a slightly more complicated picture: nearly half the respondents in Spain would leave the patients to make up their own mind while the yes has only an insignificant majority over the no. In the Netherlands about a quarter of all respondents would leave the decision to the patient, but the majority (69%) would answer yes. Only one person would answer no.



	Yes, it is real.	Yes, it is a real robot.	Yes, it is a real animal.	What do you believe?	No, it is not real.
ES	1	5	0	9	5
NL	6	4	10	8	1

Figure 2. Frequencies resolved per country. Grey signifies the Spanish and black the Dutch caregivers

So in general we find a much more positive way of answering in the Netherlands. Moreover, no respondent in Spain found positive identification with a real animal an appropriate option while more than a third of Dutch caregivers chose this answer – as much as the other two positive answers combined.

CONCLUSION AND FURTHER RESEARCH

In summary, we find that a large group of caregivers prefers to leave the answer to the patient. We find two significant differences in the country-resolved data:

- In general the Dutch respondents favor more positive answers as compared to the Spanish.
- The comparison to a real animal was chosen by about a third of all Dutch respondents and not at all in Spain.

Even though the sample size is not overly large we would not like to discount this as purely coincidental.
So further investigation is needed to answer the question

- Will we see the same tendencies in a greater sample?
- A second interesting point we have not addressed here at all, would be to look into the expectations possibly reflected in the caregivers' answers. In other words: do they expect the therapeutic value of the robot to depend on its perceived reality?
- One caregiver pointed out that her answer would depend on factors like patient type and context. It would require more in depth research to establish the influence of situational factors on caregivers' reply.

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Knuffelen met nieuwe vrienden

Een handreiking voor zorgprofessionals bij de inzet van robotdieren in de zorg voor mensen met dementie

Deze handreiking is ontwikkeld is in het kader van het SIA RAAK project *Nieuwe vrienden, oude emoties*.

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Voorwoord

Dit boekje is bedoeld als een handreiking aan professionals die werken met knuffelrobots bij mensen met dementie. We hebben op dit gebied twee jaar lang onderzoek gedaan en hebben daarbij enorme steun gehad van professionals die hun inzichten en ervaringen, maar ook hun vragen en twijfels wilden delen.

En we hopen dat ze dat blijven doen. Want op het gebied van ‘therapeutische robots’ gaat nog heel veel gebeuren, omdat er steeds meer kan wat betreft techniek en productiemethoden. Dat opent een zee van mogelijkheden om heel veel mooi werk te doen, maar die brengen ook vragen, twijfels en soms ethische dilemma’s met zich mee. En het is goed als professionals de onderzoekers meenemen in hun wereld waar dat allemaal zichtbaar wordt.

Een illustratief geval was een vrouw met dementie, die helemaal opging in het knuffelen van een robotkat. Totdat ze plots opkeek, met een vertwijfelde blik en vroeg: ‘maar is hij wel echt?’

Ik deed later een onderzoekje naar wat zorgprofessionals over het algemeen zouden antwoorden op zo’n vraag. Want dat zou het juiste antwoord zijn. Maar er kwamen verschillende antwoorden uit. En nu weet ik niet of er een juiste antwoord is.

Maar, terugdenkend aan die vrouw met die robotkat, herinner ik me haar dochter die erop reageerde. Misschien niet met het de juiste tekst, maar wel met heel veel liefde.

Misschien is dat het juiste antwoord.

Marcel Heerink

Projectleider Nieuwe Vrienden, Oude Emoties

Inhoud

1. Inleiding

Waarom knuffelrobots?

Een knuffelrobot is een robot in de vorm van een (knuffel)dier. Door middel van moderne technologie kan het robotdier reageren op menselijk contact door zelf geluid en bepaalde bewegingen te maken. De bekendste en meest geavanceerde knuffelrobot is Paro, een babyzeehond. Hij reageert op (stem)geluid en aanraking door bijvoorbeeld te spinnen, ogen open en dicht te doen of zijn kop te bewegen. Zo nodigt de knuffelrobot de mens uit om hem bijvoorbeeld te knuffelen, te aaien, op te tillen en tegen hem te praten.

In de dementiezorg worden knuffelrobots ingezet met als algemeen doel het welzijn en welbevinden van de cliënten te verbeteren. Meer specifiek worden knuffelrobots gebruikt om bijvoorbeeld bepaalde zorgactiviteiten beter/rustiger te laten verlopen, zelf contact te maken met

de cliënt of de familie dat te laten doen, een rustige sfeer te creëren of juist om cliënten te activeren.

Figuur 1. Knuffelrobot Paro

Het gebruik van knuffelrobots kan positieve effecten opleveren met betrekking tot de algemene sfeer, het contact met en tussen cliënten en zorgverleners en het gedrag van cliënten. In de praktijk ervaart men dat cliënten door middel van contact met een knuffelrobot:

- kalmeren of juist opleven;
- minder angstig en/of verward zijn;
- zich minder eenzaam en/of depressief voelen;
- vrolijker zijn, meer lachen;

- herinneringen ophalen aan vroeger (reminiscentie);
- meer en beter contact maken en communiceren met hun omgeving.

Nieuwe vrienden, oude emoties

Maar hoe bereik je deze effecten? Hoe gebruik je de robot? Voor welke cliënt is het wel of niet geschikt? Waar moet je op letten? Hoe ga je te werk bij groepen en bij individuele cliënten? Wanneer en hoe betrek je familieleden? Wat zijn de ervaringen van andere zorgprofessionals? Dit zijn enkele van de vele vragen van zorgprofessionals en mantelzorgers die met knuffelrobots (willen) werken. Er is behoefte aan informatie en praktische tips bij het inzetten van knuffelrobots in de zorg voor mensen met dementie.

Om aan die behoefte tegemoet te komen, is eind 2012 het project 'Nieuwe vrienden, oude emoties gestart. In dit project verrichtten Hogeschool Windesheim en Hogeschool Zuyd samen met professionals van 6 deelnemende ouderenzorgcentra en met de Spaanse kennispartners

LaSalle Universiteit Ramon Llull en het Alzheimercentrum van het Carlos III Instituut voor Gezondheid, praktijkgericht onderzoek naar de inzet van verschillende robotdieren:

- bij individuele patiënten en in groepen;
- in de verschillende stadia van dementie;
- de samenwerking met familie en mantelzorgers;
- de effecten die optreden.

De Spaanse partners hadden kennis van en ervaring met diverse robotdieren en metingen van het welbevinden van dementeren. Deze kennis was essentieel voor de uitvoering van het onderzoek. Daarbij werden ook in Spanje enkele metingen gedaan, om de Nederlandse data en conclusies te valideren.

Uit dat onderzoek kwamen veel nieuwe inzichten voort, die we later zullen bespreken. Maar het resultaat van het project is vooraleerst deze handreiking, waarin we zo veel mogelijk 'evidence based' antwoorden geven op de vragen van professionals in de zorg die de aanleiding waren voor het project.

Over deze handreiking…

Deze handreiking gaat dus in op de behoefte van zorgprofessionals en mantelzorgers aan handvatten bij het gebruik van knuffelrobots. Naast informatie over knuffelrobots in de dementiezorg biedt het vooral praktische adviezen en aanwijzingen. Deze zijn gebaseerd op resultaten uit bestaand en eigen onderzoek naar knuffel-/zorgrobots (vooral de zeehondrobot Paro) en verwante interventies als snoezelen en therapie met (huis)dieren. Met name de ervaringen van onderzoekers, zorgprofessionals en mantelzorgers met knuffelrobots zijn uitgangspunt geweest bij de totstandkoming van deze handreiking die gericht is op het inzetten van alle soorten knuffelrobots in de dementiezorg.

Het doel van deze handreiking is de zorgprofessional (op weg) te helpen bij het aanbieden van knuffelrobots aan mensen met dementie. Het biedt de professional inzicht in de mogelijkheden van het gebruik van een knuffelrobot. Het is met nadruk niet de bedoeling om met deze handreiking professionals een set van regels voor te leggen.

Van het grootste belang zijn immers de kennis en ervaring van de zorgprofessional met de doelgroep die de basis is van het werken daarmee. Vooral omdat binnen die doelgroep ieder mens uniek is, zoals ook iedere situatie uniek is. Zoals in de zorg gebruikelijk is, horen ook bij het gebruik van knuffelrobots de wensen en behoeften van de individuele cliënt centraal te staan.

In deze handreiking ligt de focus op de activiteit zelf. Voordat dit aan bod komt, kunt u lezen over het waarom van knuffelrobots in de dementiezorg: Wat is het doel? Wat zijn de mogelijke effecten? Hoe kunnen deze bereikt worden? Daarna volgt het hoofdstuk waarin praktische tips en aanwijzingen worden gegeven bij het voorbereiden, uitvoeren en evalueren van de activiteit met de knuffelrobot. Vervolgens worden enkele mogelijke werkwijzen beschreven en in het laatste hoofdstuk komen enkele voorbeelden uit de praktijk aan bod. Hopelijk vindt u hierin herkenning en inspiratie om zelf aan de slag te gaan met een knuffelrobot in de zorg voor uw cliënt(en).

2. Onderzoek robotdieren in de dementiezorg

Knuffelrobots worden sinds enkele jaren gebruikt in de zorg voor ouderen met uiteenlopende hulpvragen. Verschillende effectstudies hebben aangetoond dat knuffelrobots een positief effect kunnen hebben op de gezondheid en het welbevinden van dementerende ouderen. Een groot deel van deze effectstudies is met Paro, een zeehondrobot, in Japan uitgevoerd. Het betreft hier met name experimenten die plaatsvonden in een verzorgingshuis of dagactiviteitencentrum voor ouderen (Shibata et al, 2004-2005; Wada et al, 2005-2008; Wada & Shibata, 2007). In deze studies naar het effect van robottherapie wordt in beperkte mate een vertaalslag naar de praktijk gemaakt. Daardoor is nog weinig bekend over hoe men knuffelrobots kan gebruiken in de zorg.

Dit gebrek aan handvatten en richtlijnen bij het inzetten van knuffelrobots in de zorg is aanleiding geweest voor het uitvoeren van literatuurstudies naar:

1) de ervaringen van gebruikers (zorgprofessionals, mantelzorgers en cliënten) van knuffelrobots.
2) bestaande handleidingen en richtlijnen voor verwante interventies als snoezelen, therapie met poppen/knuffels en therapie met (huis)dieren.

Met de eerste literatuurstudie is getracht richtlijnen op te stellen op basis van ervaringen van zorgverleners en cliënten met het gebruik van knuffelrobots. Met de tweede studie is gekeken naar bestaande richtlijnen voor interventies die met robottherapie te vergelijken zijn, om zo een beeld te krijgen van eventuele richtlijnen voor robottherapie. Hieronder volgt een korte beschrijving van de uitkomsten van de literatuurstudies die uiteindelijk hebben geleid tot een overzicht van mogelijke richtlijnen in het gebruik van knuffelrobots in de zorg voor mensen met dementie.

Ervaringen met knuffelrobots

In de periode februari-maart 2013 is gezocht naar (internationale) literatuur over therapie of activiteiten met knuffelrobots. Naast ouderenzorg zijn doelgroepen in de gehandicaptenzorg en de geestelijke gezondheidszorg in deze studie meegenomen. Deze zoekactie leverde uiteindelijk een lijst met 23 artikelen op waarin meningen en ervaringen van gebruikers van knuffelrobots waren opgenomen.

Soort robot

De meeste artikelen gaan over robottherapie met Paro, de 'seal robot'. In alle gevallen gaat het om een activiteit voor ouderen. In de overige artikelen worden interventies beschreven met de robotkatten NeCoRo en Cleo(Libin & Libin 2003, 2005), robothond AIBO (Banks et al. 2008) en de Nabaztag (Klamer & Ben Allouch 2010), een communicatierobot in de vorm van een konijn.

Ervaringen zorgprofessionals

Als we het hebben over de ervaringen en meningen van zorgprofessionals gaat dit in de meeste gevallen om verzorgend personeel van een zorginstelling. De ervaringen van zorgprofessionals met knuffelrobots zijn over het algemeen positief van aard. Zo zien zij positieve veranderingen in het gedrag bij de cliënten na en tijdens interactie met de robot. De zorgverleners ervaren met

name positieve effecten in de communicatie en interactie met en tussen de ouderen. De robot geeft mogelijkheden voor zorgverleners en cliënten om met elkaar te praten over de robot, het uiterlijk hiervan en zijn handelen. Verder merkt men dat ouderen actiever en vrolijker worden door het contact met de robot. Het algemene beeld van de ervaringen van zorgprofessionals laat zien dat robottherapie zorgt voor een verbeterde gemoedstoestand bij cliënten en een betere sfeer in de groep en de zorginstelling.

In de meer kritische ervaringen van de zorgprofessionals komt naar voren dat de robot niet voor iedereen geschikt is. Sommige ouderen zijn bang voor de robot of willen om andere redenen niet meedoen aan de activiteit met de robot, bijvoorbeeld omdat zij niet van dieren houden of omdat zij geagiteerd raken door het geluid van het dier. Daarnaast vragen sommige zorgverleners zich af in hoeverre het stigmatiserend is om hun cliënten met een robot te laten 'spelen'. Zij hebben het idee dat zij de ouderen voor de gek houden, omdat deze het soms moeilijk vinden de robot niet als een levend wezen te beschouwen en te benaderen. Verder wordt de behoefte aan richtlijnen en methodiek voor het gebruik van knuffelrobots door zorgverleners genoemd. De professionals weten vaak niet precies hoe zij met robot om moeten gaan of hoe zij deze het beste in kunnen zetten in de zorg voor hun cliënten.

Ervaringen mantelzorgers

Uit de literatuur komt naar voren dat kinderen van ouderen met dementie ervaren dat zij dankzij de robot beter met hun ouders communiceren. Zij zien dat het hun ouder(s) helpt in het uiten van gevoelens en emoties. Ze zien dat hun ouder meer lacht en minder last heeft van eenzaamheid. Net als de zorgprofessionals denken mantelzorgers dat de robot minder geschikt is voor mensen die niet van dieren en/of knuffelen houden. Daarnaast ervaren ook zij de behoefte aan richtlijnen in het aanbieden van een knuffelrobot.

Ervaringen cliënten

Over het algemeen zijn de ervaringen van cliënten positief. Mensen vinden het leuk om contact te maken met de robot. Ze worden er blij van en voelen zich minder eenzaam wanneer de robot in de buurt is om bij te zijn of mee te

praten. Daarbij zorgt de robot ervoor dat mensen meer bij elkaar gaan zitten en met elkaar gaan praten. Ouderen in een verzorgings- of verpleeghuis geven aan dat de sfeer in de groep beter is door de aanwezigheid van de robot (Paro). In sommige gevallen geven cliënten de robot een nieuwe naam of gaan liedjes voor de robot zingen. Met name vrouwen behandelen de robot als een (klein)kind/baby. Mannen zijn soms meer geïnteresseerd in de technische kant en willen weten hoe de robot werkt.

Een aantal cliënten geeft aan niets met de robot te willen doen, omdat het niet een echt dier is of omdat ze er bang voor zijn. Anderen (met name mannelijke cliënten) vinden het kinder- of meisjesachtig om met een dergelijk knuffeldier te spelen of vinden het saai omdat de robot niet kan praten.

Ervaringen met verwante interventies

Therapie of activiteiten met knuffelrobots hebben overeenkomsten met interventies waar in de zorg al langer mee gewerkt wordt, zoals snoezelen en therapie met echte (huis)dieren of met poppen en knuffels. De belangrijkste overeenkomst is dat al deze interventies, net als robottherapie, zijn gericht op het stimuleren van de zintuigen.

Dat deze verwante interventies al langer bestaan en worden toegepast, betekent dat hier wellicht handleidingen en bepaalde methoden voor zijn ontwikkeld. Om die reden hebben we in de literatuur gezocht naar richtlijnen voor de genoemde verwante interventies, zodat we deze kennis kunnen gebruiken in het opstellen van richtlijnen of een handreiking voor het gebruik van knuffelrobots. De volgende verwante interventies zijn onderwerp geweest van de literatuurstudies:

- **Snoezelen**

Snoezelen is een activiteit gericht op het prikkelen van de zintuigen, daarom ook wel zintuigactivering genoemd. Bij snoezelen gaat het om het positief prikkelen van de zintuigen. We definiëren snoezelen als een methode gericht op het actief stimuleren van de zintuigen horen, voelen,

zien en ruiken in een cliëntgerichte en vertrouwde omgeving (van Weert et al, 2005).

- **Therapie met poppen en knuffels**

Hierbij gaat het om therapie met niet-mechanische poppen en knuffels die gebruikt worden in de zorg voor mensen met dementie.

- **Therapie met dieren (animal assisted therapy)**

Therapie met dieren, ook wel dierondersteunde therapie genoemd, wordt al enige decennia ingezet in de behandeling en begeleiding van uiteenlopende doelgroepen. De Engelse en veelgebruikte term hiervoor is ‘animal assisted therapy’. Deze term duidt therapie met alle soorten dieren aan. Veelvoorkomend is het gebruik van (huis)dieren als katten, honden, konijnen, paarden en dolfijnen.
Bij het zoeken naar (internationale) literatuur over deze verwante interventies zijn veel artikelen en studies gevonden naar de effecten en de toepassing van snoezelen. Van therapie met knuffels en poppen is geen bruikbare literatuur gevonden. Ook over therapie met dieren is weinig

gevonden. De resultaten over verwante interventies die we hier beschrijven zijn dus met name afkomstig uit studies die gericht zijn op snoezelen als therapie of activiteit voor ouderen met dementie.

- **Verwante interventies, verwante effecten**

Uit de literatuur komt naar voren dat snoezelen soortgelijke positieve effecten kan hebben als het werken met knuffelrobots. Zo kan snoezelen bij mensen met dementie zorgen voor een verbeterde stemming en gedrag. Dit houdt onder meer in dat mensen tijdens en/of na deelname aan een snoezelactiviteit meer blijdschap tonen, actiever zijn en meer communicatie en interactie met hun omgeving hebben. Verder kan snoezelen zorgen voor verminderde apathie en agitatie.

De mogelijke effecten van therapie met dieren komen overeen met die van snoezelen en robottherapie. Zo kan dierondersteunde therapie bij mensen met dementie verminderd apathisch en geagiteerd gedrag tot gevolg hebben. Verder zou het kalmerend werken en ziet men een verbetering in sociaal gedrag wat zich uit in meer lachen en praten, meer interactie met de omgeving. Kortom, net als

robottherapie kunnen verwante interventies als snoezelen en dierondersteunde therapie met name in de communicatie en interactie met en tussen cliënten effectief zijn.

Aanbevelingen en richtlijnen voor verwante interventies

In de periode februari-maart 2013 is gezocht naar (internationale) literatuur waarin richtlijnen of aanbevelingen worden gegeven voor het toepassen van snoezelen, dierondersteunde therapie en therapie met poppen en knuffels. In totaal zijn 22 artikelen gevonden. Zoals gezegd is over therapie met poppen en knuffels geen bruikbare literatuur gevonden. De meeste artikelen gaan over snoezelen (15/22). Verder zijn zes artikelen gevonden waarin therapie met dieren centraal staat. In één artikel komen beide interventies aan bod.

Snoezelsessies

In de gevonden artikelen is gekeken naar beschreven richtlijnen en/of methoden in het toepassen van de interventies. Zo blijkt uit de literatuur dat het snoezelen of 'multisensory stimulation' een therapie is die veelal volgens een vaste methode wordt aangeboden. De activiteit vindt in de meeste gevallen plaats in een aparte ruimte die speciaal is ingericht voor het aanbieden van snoezelactiviteiten. Dit houdt in dat de ruimte is ingericht met onder andere verschillende kleuren lampen, spiegels, muziek en geurende oliën (Pinkney, 1997). Een snoezelsessie is doorgaans individueel van aard (één-op-één begeleiding) en duurt gemiddeld een half uur. Een snoezelsessie wordt meestal begeleid door een personeelslid van de zorginstelling die getraind is in het toepassen van de snoezelmethode.

Werken met dieren

Aan dierondersteunde therapie of 'animal assisted therapy' lijkt in de praktijk een minder vaste methode te zitten dan bij snoezelen. Veelal gaat het om bezoekhonden of –katten die voor een bepaalde tijd in de woon- of leefruimte van

deelnemers verblijven. Het kan dan zowel om een individuele als een groepssessie gaan. De dieren worden meestal vergezeld door hun baas of begeleider. Dit kan een zorgprofessional van de instelling zijn, maar vaak is het een externe kracht die niet specifiek getraind is in het aanbieden van de activiteit met het dier.

Vooral voor snoezelen zijn in de literatuur richtlijnen gevonden, soms in de vorm van een handleiding. Verder hebben we in de literatuur gekeken naar de inhoud, werkwijze en benodigde competenties voor snoezelen en dierondersteunde therapie. Dit heeft een overzicht opgeleverd van de belangrijkste (meest genoemde) aanbevelingen en richtlijnen voor de interventies. Dit overzicht hebben we vervolgens naast de eerder beschreven ervaringen met knuffelrobots gelegd. Zo zijn we tot een set van richtlijnen gekomen die mogelijk geschikt is voor het inzetten van knuffelrobots in de zorg voor mensen met dementie.

Bevindingen van nieuwe (veld)studies

Binnen het project *Nieuwe Vrienden, oude emoties* hebben we een aantal studies gedaan met mensen met dementie, aangevuld door interviews met zorgprofessionals in Spanje en Nederland (Heerink et al. 2013 a en b, Heerink 2014, Heineman et al. 2014). De vragen die we daarin beantwoord wilden zien waren:

- Is een zeehond inderdaad de meest geschikte vorm voor een robotdier in deze context?
- Zijn er verschillen tussen mensen met dementie in de reactie op robotdieren?
- Zijn er ervaringen van zorgprofessionals die tot richtlijnen kunnen leiden voor het werken met robotdieren voor ouderen met dementie?
- Zijn er verschillen in inzichten tussen mantelzorgers en zorgprofessionals wat betreft inzichten en behoefte aan richtlijnen?
- Zijn er verschillen tussen inzichten van zorgprofessionals met en zonder ervaring en tussen Spanje en Nederland?

Om de eerste twee vragen te beantwoorden, registreerden we de reacties van mensen met dementie op zeven robotdieren: een hondje, een kat, een teddybeer, een zeehond, een aap, een pinguïn en een koalabeertje. We keken daarbij zowel naar de reacties op de dieren zonder dat die bewogen of geluid maakten (als ze uit stonden) als wanneer ze wel bewogen en geluid maakten. De dieren waren daarbij allemaal zo’n 30 centimeter groot en in staat om armen en hoofd te bewegen als reactie op een aanraking. Ze maakten daarbij een zacht piepend geluid, aangepast aan wat voor het betreffende dier natuurlijk is.

De belangstelling voor de zeehond bleek daarbij niet groter dan die voor een hond of een kat, en de aap en de koala bleven daar slechts iets bij achter. De pinguïn scoorde nauwelijks en met de teddybeer was opvallend dat de belangstelling even groot was als bij zeehond, kat en hodn zolang hij niet bewoog, maar dat die belangstelling verdween zodra hij bewoog. Een verklaring daarvoor zou kunnen zijn dat een teddybeer bekend en vertrouwd is als ‘levenloze’ knuffel, maar niet als bewegende robot.

Onze conclusie dat een zeehond niet in alle gevallen de meest geschikte vorm was, werd bevestigd door zorgprofessionals. Velen bleken al ervaring te hebben met goedkope robots uit de speelgoedwinkel. Dat was soms ook vanwege een beperkt budget: zeehond Paro kost rond de 6.000 euro, terwijl een robotdier in een speelgoedwinkel al voor rond de 50 euro te koop is. Ze merkten dat voor veel activiteiten deze goedkope dieren effectief genoeg waren. Soms zelfs beter, omdat ze veel minder zwaar zijn.

Verder merkten we sterke persoonlijke verschillen: mensen waarbij een zeehond geen enkel effect had, reageerden vaak wel positief op een kat of een hond. En anderen reageerden juist meer op een aap of een koalabeer. Een therapeute in Madrid riep toen ze dat merkte uit dat ze eigenlijk een doos vol dieren nodig had om met alle deelnemers van haar groep te kunnen werken.
Wat betreft verschillen tussen zorgprofessionals merkten we dat er over het algemeen juist veel overeenkomsten zijn. Waar er verschillen waren, konden we die niet herleiden tot land, opleiding of ervaring. Wel zagen we dat mantelzorgers met een partner met dementie minder

behoefte hadden aan richtlijnen. Ze wilden graag zelf uitzoeken wat bij hun partner wekte, uitgaande van de persoonlijke kennis die ze van hun man of vrouw hadden.

3. Praktische gebruiksaanwijzingen

In dit hoofdstuk geven we enkele aanwijzingen voor de inzet van robotdieren die op dit moment te koop zijn. Ongetwijfeld wordt er door fabrikanten van medische hulpmiddelen als door speelgoedfabrikanten gewerkt aan nieuwe dieren. Op de site *robots.nu* wordt bijgehouden wat er recentelijk op de markt verschenen is en we raden aan om daar een bezoekje aan te brengen als u van plan bent om een robotdier aan te schaffen.

Achterin dit boekje hebben we overigens de URL’s van ons bekende leveranciers en fabrikanten opgenomen.

Wat zijn bruikbare robotdieren?

Er zijn robotdieren die speciaal ontwikkeld zijn voor mensen met dementie, zoals Paro, die circa 6.000 euro kost en JustoCat, die rond de 1.300 euro kost. Beide robots zijn vrij zwaar (bijna 3 kilo). Paro is ongetwijfeld de meest geavanceerde:

- Hij kent een dagritme van de ochtend, middag en avond
- Hij heeft vijf soorten sensors: aanraking, licht, geluid, temperatuur en houding/positie
- Hij kan licht en donker te herkennen
- Hij kan voelen dat hij wordt geaaid, inclusief de hoeveelheid druk
- Hij begrijpt wanneer hij wordt vastgehouden
- Hij herkent de richting van geluid
- Hij herkent zijn naam, verschillende begroetingen, en loftuitingen
- Hij onthoudt interacties en past zich aan
- Hij geeft uiting aan gevoelens met geluiden, bewegingen en oogbewegingen

Figuur 2. JustoCat van Robyn Robotics

JustoCat is iets eenvoudiger: hij voelt wanneer hij wordt geaaid en geknuffeld, gaat naar aanleiding daarvan spinnen, is warm, je voelt hem licht trillen als hij spint. Een voordeel is dat je de vacht eraf kunt halen en wassen. Dat kan bij Paro helaas niet.

Verder worden er vaak speelgoeddieren gebruikt. Een voorbeeld hiervan is de *Wowwee Alive* serie, waar onder meer een zeehondje in voorkomt dat circa 40 euro kost. Het robotje is weliswaar interactief (het reageert op aanraking met geluidjes en bewegingen), maar heeft natuurlijk niet de geavanceerde technologie van Paro. Het is ook een stuk kleiner en lichter (nog geen halve kilo), wat een voordeel kan zijn voor mensen die weinig kracht in de armen hebben.

Figuur 3. Paro (links) en het zeehondje van Wowwee Alive.

Figuur 4. Lulu van Furreal Friends

Een andere veelgebruikte serie is *Furreal Friends* van fabrikant Hasbro. Met name de kat ‘Lulu’, die zo’n 50 euro kost wordt veel ingezet. Deze kat reageert op aanraking met spingeluidjes en met en optillen van een voorpoot, zodat je de buik kunt aanraken.

De speelgoeddieren zijn goed in te zetten in groepsactiviteiten, vooral als gewerkt wordt met meerdere robotdieren. Wel zullen ze niet altijd de impact hebben van Paro en JustoCat, omdat ze zo licht zijn en meer mechanisch geluid maken. Het ‘speelgoedgevoel’ dat daardoor wat eerder bij de gebruiker opkomt wordt nog eens versterkt doordat de aan- en uitknop onder de vacht zit: die moet opengetrokken of –geritst worden en vaak is het dan ook nog even zoeken naar het juiste knopje.

Helaas zijn speelgoeddieren in de regel slechts enkele jaren verkrijgbaar in de speelgoedhandel. Via Marktplaats en Ebay zijn ze daarna echter nog volop verkrijgbaar.

Enkele praktische instructies

Paro

De robot is vrij eenvoudig te gebruiken. Tussen de staart zit een klein aan- uit- knopje verscholen. Wanneer hij wordt aangezet maakt hij een geluid en bij het uitzetten gaan de voor- vinnen een klein beetje uit elkaar en het hoofd naar beneden (soort slaaptoestand). Opladen van de batterij gaat middels een oplader in de vorm van een speen, het duurt ongeveer 4 uur op hem volledig op te laden. Tussen de speen, die in de mond geplaatst dient te worden, en de stekker zit een zwarte transformator (kastje) met 2 lampjes. Als 1 lampje brandt, maakt de stekker goed contact en indien beide lampjes branden wordt de robot

opgeladen. Tijdens het opladen kan de robot gewoon aanstaan en functioneren.
De vacht heeft weliswaar een anti- bacteriële en vuil- afstotende laag, maar bij veelvuldig en langdurig gebruik zal hij verkleuren en de afstotende werking verliezen. De robot mag niet schoongemaakt worden met water of andere reinigingsmiddelen maar moet gebeuren door deskundige en daartoe uitgeruste instanties.

JustoCat

Deze robot heeft het voordeel dat de vacht eraf gehaald en gewassen kan worden. Hij wordt bovendien standaard geleverd met een extra vacht en mochten beide vachten niet meer bruikbaar zijn, dan is het gemakkelijk een nieuwe te bestellen.

De aan/uitknop zit op de buik en moet lang (zo'n 5 tot 10 tellen) ingedrukt worden. De oplader met transformator kan aangesloten worden om hem in circa twee uur te laden en gedurende die tijd kan JustoCat ook gebruikt worden.

Furreal Friends en Wowwee Alive

De speelgoeddieren hebben in de regel geen afneembare vacht, maar ze kunnen schoongemaakt worden met desinfecterende spray (al zal de vacht wel iets verkleuren na verloop van tijd). De knop voor het aan- en uitzetten zit altijd verborgen, zodat de vacht (meestal op de plaats van de onderbuik) opengetrokken of opengeritst moet worde om erbij te komen. Naast die knop zit overigens ook de plaats voor de batterijen.

De speelgoeddieren gaan in de regel pas bewegen en/of geluid worden nadat ze zijn aangeraakt.

4. Aanwijzingen voor activiteiten

Voor wie?

- Voor mensen met een vorm van dementie, thuiswonend of verblijvend in een zorginstelling.

Knuffelrobots hebben niet altijd en bij iedereen het gewenste effect. Het is moeilijk hier aan te geven voor welke personen de inzet van een knuffelrobot wel of niet geschikt is. In principe zijn knuffelrobots geschikt voor iedereen, zolang het aansluit op de wensen en behoeften van de cliënt. In de praktijk vraagt dit vooral inzicht van de zorgprofessional in de persoon en de situatie.

Op basis van de ervaringen in praktijk blijken knuffelrobots **het meeste effect** te hebben bij mensen:

- in een gevorderd stadium van dementie (fase 3);
- die zelf dieren hebben of hadden en/of van (huis)dieren houden;
- die moeite hebben met menselijk contact.

Door wie?

- Door alle verschillende denkbare disciplines in de zorg voor mensen met dementie, zoals verzorgenden, verpleegkundigen, fysiotherapeuten, psychotherapeuten, activiteitenbegeleiders en vrijwilligers of andere niet-professionals.
- Door een vaste en voor de cliënt bekende/vertrouwde zorgverlener.
- Door mantelzorgers. Belangrijk is dan dat zij op de hoogte zijn van het gebruik van de robot en eventueel de ervaring van de zorgprofessional met de desbetreffende cliënt in het werken met de robot.

Het is van belang cliënten niet alleen te laten met de robot. Dit om eventuele escalaties en negatieve effecten te voorkomen. Tijdens de activiteit met de knuffelrobot kunnen gevoelens en emoties loskomen bij de cliënt. Om deze in goede banen te leiden en de cliënt hierbij te ondersteunen is het van belang dat er altijd iemand bij de cliënt met de knuffelrobot aanwezig is.

Wat is nodig?

Middelen

Voor het inzetten van knuffelrobots zijn in de praktijk geen specifieke middelen nodig anders dan de robot en zijn toebehoren (opberg- en oplaadmateriaal).

Kennis en vaardigheden zorgprofessional

Voor de zorgprofessional is het van belang te weten hoe de robot werkt en hoe deze in de praktijk ingezet moet/kan worden. Dit om de veiligheid tijdens de activiteit te waarborgen en de robot op de meest geschikte manier in te zetten. Verder zijn, zoals eerder genoemd, de kennis en ervaring van de zorgprofessional met de doelgroep onmisbaar in het werken met de knuffelrobot. Hoe de robot in te zetten is altijd afhankelijk van de situatie en vraagt het nodige inzicht van de professional hierin.

Beleid zorginstelling

Het is aan te bevelen binnen zorginstellingen een protocol op te stellen voor het gebruik van de knuffelrobot, zodat professionals eenzelfde werkwijze hanteren.

Waar?

De activiteit

Het is aan te bevelen de robot aan te bieden in een voor de cliënt veilige en vertrouwde omgeving. In de meeste gevallen zal de eigen kamer of een gezamenlijke woonruimte het meest geschikt zijn.

De robot

Het is aan te bevelen de knuffelrobot een vaste verblijfplaats te geven. Het is afhankelijk van de cliënt(en) en/of de woongroep welke optie de juiste is. De robot kan:

- in het zicht van de cliënt(en) verblijven, bijvoorbeeld in een kooi of in een mand. Gekozen kan worden voor vrije toegang (cliënten kunnen de robot pakken wanneer ze willen) of toegang op vaste tijden of wanneer cliënten erom vragen.

- buiten het zicht van de cliënt(en) verblijven, bijvoorbeeld in een kast of het kantoor van het personeel.

Wanneer?

- Op momenten van onrust, verdriet, agressie: om cliënten te kalmeren.
- Op momenten van rust: om cliënten desgewenst te activeren.
- Als hulpmiddel om contact te maken met cliënten die in zichzelf gekeerd zijn.
- Als familie/bezoek langskomt: om de cliënt te stimuleren, spanning te verminderen, de sfeer te verbeteren, houvast te bieden en/of als middel om contact te maken.

Duur van de activiteit

Over het algemeen wordt aangeraden de activiteit niet langer dan 20 minuten te laten duren. Uiteraard is de duur afhankelijk van de persoon en de situatie. Het is belangrijk gedurende de activiteit alert te zijn op overprikkeling bij de cliënt vanwege de, soms onverwachte, emoties en gedragingen die door het contact met de robot opgeroepen kunnen worden.

Hoe?

Mogelijkheden

Er zijn velerlei manieren voor het inzetten van knuffelrobots. Ook hier geldt dat de meest geschikte werkwijze afhangt van de persoon en de situatie. Het advies is om hiermee te experimenteren. Kijk wat werkt voor welke cliënt in welke situatie en rapporteer hierover. In het volgende hoofdstuk worden enkele voorbeelden van meer specifieke werkwijzen gegeven.

In groepsverband of individueel?

Beide is mogelijk. Als activiteit met een individuele cliënt is het voordeel dat de zorgprofessional de activiteit beter op de persoon en de situatie kan afstemmen. In groepsverband is de ervaring dat sommige cliënten moeite hebben met het ‘delen’ van de robot, dus dat ze hem niet aan een ander

willen geven. De ervaring leert wel dat het aanbieden van de robot in een groep vooral een positief effect heeft op de communicatie en interactie met en tussen cliënten en daarmee op de sfeer in de groep.

Werkwijzen

We geven nu enkele mogelijke werkwijzen bij het inzetten van knuffelrobots. Na het benoemen van een aantal aandachtspunten geven we hier een voorbeeld van een werkwijze bij een groepsactiviteit en activiteiten met een individuele cliënt in twee verschillende situaties: het activeren van een cliënt en het voorkomen van onrust bij een bepaalde zorgactiviteit.

Aandachtspunten

Een aantal punten om voor, tijdens en/of na de activiteit rekening mee te houden zijn:

- Zorg ervoor dat de robot volledig opgeladen is. Cliënten kunnen verward raken of emotioneel worden als de robot tijdens de activiteit uitvalt.

- Blijf bij de cliënt als die in contact is met de robot om eventuele gevoelens en gedragingen van de cliënt tijdens de activiteit in goede banen te leiden.
- Blijf tijdens de activiteit in contact (praten en/of aanraken) met de cliënt én de robot.
- Robot of levend wezen? Laat de cliënt bepalen of hij/zij het als een robot of een knuffel of een echt dier beschouwt. Als een cliënt vraagt wat het is, zeg dan bijvoorbeeld ‘Wat denkt u dat het is?’ om het zoveel mogelijk op de belevingswereld van de cliënt aan te laten sluiten.
- Evalueer de activiteit (eventueel met de cliënt) en rapporteer hierover, zodat dit meegenomen kan worden in het volgende contactmoment met de knuffelrobot.
- Geef de robot (eventueel samen met de cliënt) een naam of benoem het dier (bijvoorbeeld zeehond, kat of hond).

Groepsactiviteit

- Introduceer de knuffelrobot aan de groep door bijvoorbeeld te zeggen: “Kijk eens wat ik hier heb.”
- Leg de robot eerst in het midden van de groep en wacht de reacties van de deelnemers af.
- Vertel eventueel over de robot: hoe hij eruit ziet, wat hij doet, wat hij fijn vindt.
- Praat zelf tegen de robot en aai het dier.
- Vraag deelnemers of zij de robot willen aanraken of vasthouden.
- Introduceer de robot eventueel nog een keer als je deze bij een cliënt brengt of op schoot zet.
- Vraag deelnemers wat zij van de robot vinden.
- Neem gezamenlijk afscheid van de robot door bijvoorbeeld te zeggen: “De zeehond gaat nu weer terug naar zijn mand om te slapen” of “Tot de volgende keer, zeehond”.
- Laat iedere deelnemer afscheid nemen van het dier zoals hij/zij dat wil.

Activiteit met individuele cliënt

Het activeren van de cliënt

- Introduceer de robot, bijvoorbeeld door te zeggen: “Kijk mw./mr., dit is een zeehondje, hij blijft nu even bij u zitten. U mag hem vastpakken, maar hij mag ook op tafel blijven liggen.”
- Leg de knuffelrobot tijdens de activiteit zo neer dat de cliënt hem aan kan raken wanneer hij/zij dat wil.
- Blijf de cliënt eraan herinneren dat de knuffelrobot er is.
- Vertel over de robot: wat hij doet, hoe hij eruit ziet, wat hij fijn vindt.
- Praat zelf tegen de robot en aai het dier om de cliënt te stimuleren dit ook te doen.
- Vraag de cliënt wat hij/zij van de robot vindt.
- Neem aan het einde van de activiteit samen afscheid van de knuffelrobot door bijvoorbeeld te zeggen: “Zeehond, tot de volgende keer. Wilt u ook nog iets tegen de zeehond zeggen, mw./mr…..?”

Het voorkomen van onrust tijdens een zorgactiviteit

- Introduceer de knuffelrobot voordat de zorgactiviteit plaatsvindt door bijvoorbeeld te zeggen: “Kijk mw./mr., dit is een zeehondje, hij gaat met u mee naar ….(het toilet)”.
- Zorg ervoor dat de cliënt de knuffelrobot tijdens de zorgactiviteit aan kan raken, door hem bijvoorbeeld op een krukje naast de cliënt neer te zetten.
- Praat zowel tegen de cliënt als tegen de robot. Herinner de cliënt eraan dat de robot er is. Vertel over de robot en betrek hem eventueel bij de activiteit om de cliënt waar nodig af te leiden.
- Neem aan het eind van de activiteit samen afscheid van de robot.

Voorbeelden uit de praktijk

Voorbeelden van positief gedrag

In contact met een knuffelrobot zijn bij cliënten de volgende positieve gedragingen geobserveerd:

- knuffelen;
- aaien;
- praten tegen de robot;
- lachen;
- kusjes geven;
- reageren op het geluid van de robot;
- liedjes zingen;
- een naam bedenken voor de robot;
- aan anderen willen laten zien;
- anderen over de robot (willen) vertellen.

Voorbeelden van minder positief gedrag

In contact met een knuffelrobot zijn bij cliënten de volgende minder positieve of negatieve gedragingen geobserveerd:

- de robot niet willen aanraken;

- bang zijn (bijvoorbeeld dat de robot bijt);
- er niets mee te maken willen hebben/negeren;
- de robot slaan of op de grond gooien;
- de robot niet willen delen met andere cliënten (bij een groepsactiviteit).

Ervaringen van zorgprofessionals

Een zorgprofessional die ervaring heeft met het inzetten van de zeehondrobot Paro bij bewoners met een vorm van dementie zegt hierover:

> *“[..] het is een fijn beest om mee te werken. Alleen is het jammer dat je niet weet hoe je er het beste mee om kan gaan. Er is daar nog niets over bekend. Het was in het begin zoeken hoe je Paro het beste kunt gebruiken. Dit is ook afhankelijk van de oudere. De ene oudere reageert heel natuurlijk en de andere wat minder.*
> *Er is voor gekozen om altijd een begeleider aanwezig te laten zijn. Zo is er altijd iemand bij als het fout dreigt te gaan. Verder introduceert iemand Paro altijd: “hier komt Paro weer aan”. De ouderen weten dat hij komt*

en reageren hier op. Het is belangrijk om Paro rustig op schoot of op tafel te zetten en er bij te praten.

Door Paro bij iemand te brengen zie je hoe diegene reageert en kun je een gesprek aangaan. Wij zien de ouderen opleven als ze met Paro bezig zijn. Doordat een van ons er altijd bij is kunnen we een gesprek voeren. Soms tonen de ouderen ook emoties door met Paro te praten. Of bedenken ze hoe Paro zich voelt. De kans is groot dat zij zichzelf zo voelen. Daar kan je dan over praten met de ouderen en eventueel de familie.

Paro geeft gesprekstof en helpt het contact tussen de cliënt en begeleiders op gang te helpen en te onderhouden. Het is belangrijk dat er wel altijd een begeleider bij is, zo kunnen situaties niet uit de hand lopen en kan het gesprek worden aangegaan.''

Praktijksituaties

Hier volgen vier voorbeelden van situaties die zich in de praktijk hebben voorgedaan tijdens sessies met zeehondrobot Paro.

1. Het gaat om een vrouw (met een lichte tot matige vorm van Alzheimer) tijdens een eerste groepssessie met Paro. Ze vindt hem wel leuk, maar ze is er een beetje bang voor. Ze vindt het leuk om naar te kijken, maar ze wil hem niet aanraken of dichtbij zich hebben. De zorgprofessional vraagt of ze wil stoppen of met Paro naar een andere ruimte wil gaan, maar ze wil graag gewoon even blijven kijken. Na een aantal weken en frequent contact met Paro tijdens de groepssessies gaat de vrouw hem steeds leuker vinden. Na drie maanden vindt de vrouw de zeehond zo leuk dat ze hem niet weer kwijt wil. Ze knuffelt Paro stevig en zegt dat ze hem voor altijd bij haar wil hebben.

2. Tijdens een groepssessie met mensen met een lichte tot matige vorm van dementie wil een vrouw kijken

wat er onder de vacht van Paro zit. Ze keert de zeehond om en probeert het klittenband los te maken. De vrouw naast haar wordt hier zenuwachtig van en zegt dat ze Paro niet pijn moet doen. De vrouwen hebben een verschillende kijk op Paro is en dat zorgt in deze situatie voor spanning bij de cliënten.

3. Het gaat om een vrouw (met een ernstige vorm van Alzheimer) die weinig contact heeft met haar omgeving. Ze maakt geen oogcontact en houdt niet van lichamelijk contact. Als de zorgprofessional Paro bij haar introduceert, kijkt ze hem in de ogen en raakt hem voorzichtig aan. Ze lijkt hem niet te herkennen, maar bij elke nieuwe sessie vindt ze Paro meteen leuk en maakt contact met de zeehond.

4. Tijdens een sessie begint een vrouw (met een lichte tot matige vorm van dementie) te spelen met Paro. Ze kijkt hem in de ogen en lacht naar hem, terwijl de zorgprofessional met haar praat over zeehonden en wat zij zoal eten. Opeens zegt de vrouw verdrietig dat

Paro maar speelgoed is en niet een echte zeehond. De zorgprofessional zegt dat dit klopt en vraagt of wil stoppen. De vrouw schudt haar hoofd. Ze vindt het leuk om bij Paro te zijn en erover te praten met de professional. Ze wil niet stoppen alleen maar omdat het niet een echte zeehond is. Aan het eind grapt ze nog: ‘hij is eigenlijk wel schoner dan een echte zeehond omdat hij niet naar vis stinkt!’.

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URL’s

http://www.robots.nu – Een site waarop onder meer beschikbare robotdieren worden weergegeven

http://www.hasbro.com/nl_NL - De Amerikaanse fabrikant Hasbro van de Furreal Friends robotdieren. Overigens is ook Furby van Hasbro.

http://www.wowwee.com/ - Fabrikant Wowwee van de Wowwee Alive serie.

http://www.parorobots.com/ - De site van Paro. In Nederland is Paro te koop bij Focal Meditech:

http://www.focalmeditech.nl/

http://www.justocat.com/ - De site van de Zweedse JustoCat.

http://www.newfriends.nu - De site over projecten projecten rond therapeutische sociale robots van het lectoraat Robotica van Hogeschool Windesheim. Ook het project *Nieuwe Vrienden, Oude Emoties* valt hieronder.

http://www.technologyincare.nl – De site van het lectoraat Technologie in de Zorg van Hogeschool Zuyd.

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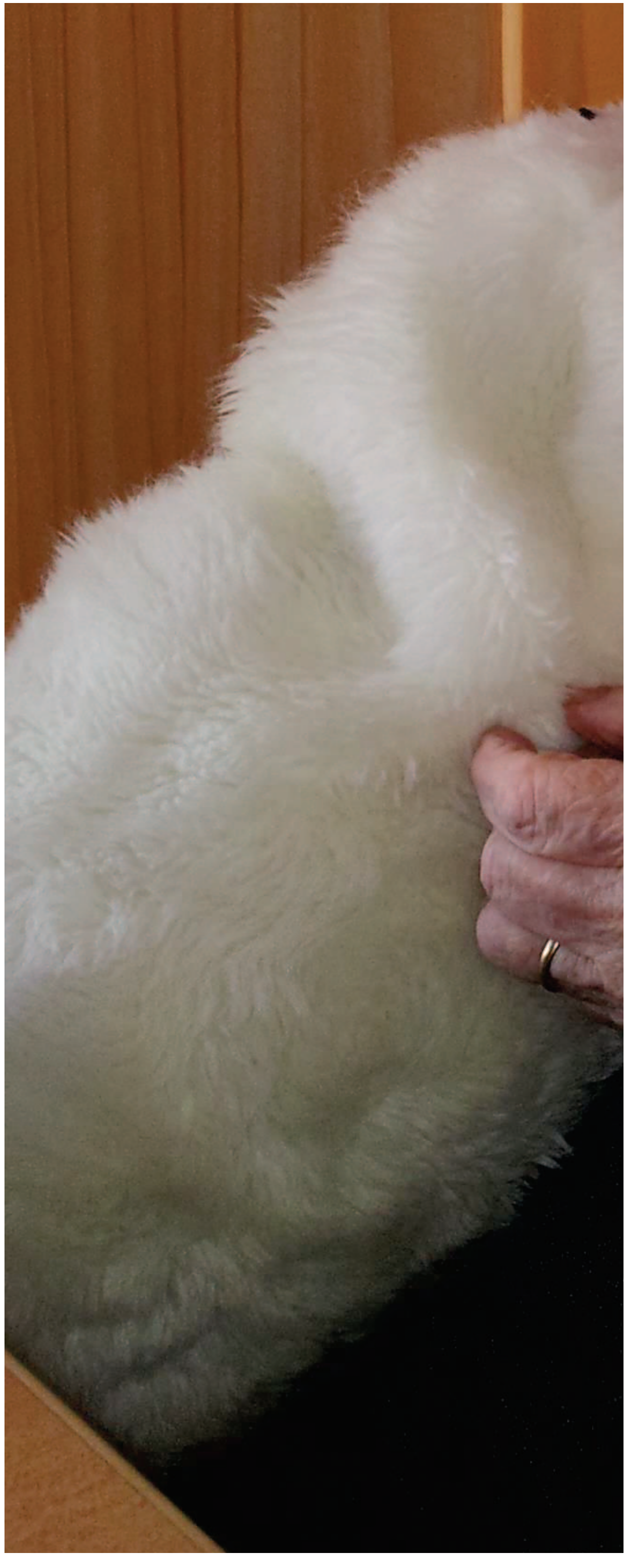

Exploring requirements and alternative pet robots for robot assisted therapy with older adults with dementia

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***Abstract*.** Robot assisted therapy has been applied in care for older adults who suffer from dementia for over ten years. Strong effects like improved interaction and signs of a higher sense of wellbeing have been reported. Still it is unclear which features are needed and which robotic pets would are suitable for this therapy. In this explorative research we interviewed 36 professional caregivers, both experienced and inexperienced in relationship to RAT and compiled a list of requirements. Next, we used this list to compare commercially available robotic pets. We found that many pet robots are usable, although seal robot Paro meets the requirements best, being superior on sustainability, realistic movements and interactivity. Finally, a test with alternative pets showed that different subjects were attracted to different pets and a subsequential questionnaire revealed that some caregivers were not only willing to try alternatives for Paro, but also suggesting that alternative pets could in some cases be more suitable.

1 INTRODUCTION

For more than a decade, research has been done on the use of robotic pets for older adults suffering from dementia, suggesting this is a successful form of therapy [1-4]. Although most research has been done in Japan and with the same seal shaped robot called Paro, it is generally assumed that therapeutic use of robotic pets improves mental and physical wellbeing of older adults with dementia and results in a more active interaction of the subjects with their environment [5].

Although there are some alternatives [6-10], Paro is by far the most widely used robotic pet for this purpose. This could be due to the fact that Paro is the only robotic pet that is both especially developed for this purpose and commercially available. However, Paro is quite an investment since it costs close to five thousand dollars [11]. Eldercare professionals that would like to try working with a robotic pet but have a

adfa, p. 1, 2011.

very limited budget may look for alternatives. These would be pet robots meeting the requirements that make them suitable for robot-assisted therapy in dementia.

In this explorative study we want to elicit and specify these requirements by focusing on professional caregivers working with older adults who suffer from dementia. These caregivers may have experience with similar types of interventions, like using real pet animals, stuffed animals or other techniques that stimulate the senses for which the term‘snoezelen’ is used. Snoezelen is also called or Multi-Sensory Stimulation (MSS), and is a widely used and accepted approach to nursing home residents suffering dementia [12].

The caregivers that are subject to our study may or may not be familiar with robot-assisted therapy. If they are not, this could be due to the unfamiliarity of the possibilities of this form of therapy, but also by inaccessibility to practical guidelines: for caregivers who are interested in applying this therapy, there are hardly any practical guidelines available on how to use which type of robot in which state of dementia, how to deal involve family members and how to respond to any negative responses. It could in that case very well be that comprehensible set of guidelines would lead to a wider application of robot-assisted therapy.

Caregivers who are familiar with robot-assisted therapy - and especially the ones who have applied it - may give different responses when asked for the requirements for a suitable robot.

This paper presents the results of an explorative study. The goal was to elicit and specify requirements according to professional caregivers for a pet robot that can be used in therapeutic interventions with older adults suffering from dementia. Moreover, we wanted to establish how familiarity with this form of therapy and the experience of applying it would influence the elicitation and specification of these requirements.

Fig. 1. Paro

In our present study, we wanted to map (a) the familiarity of robot-assisted therapy for professional caregivers in Spain and the Netherlands, (b) the need for guidelines by professional caregivers in Spain and the Netherlands, (c) produce an inventory of requirements for a suitable robot according to these caregivers and (d) produce a comparison of available pet robots based on these requirements (e) describe professionals'reactions to the use of pet robots in a small experiment.

In the following section we will present the project of which this study is a part. Next, we will discuss the used questionnaire and respondents subsequently we will present the results of (a) questions on experience and guidelines and (b) the requirements inventory. After drawing some preliminary conclusions from this, we will compare a few alternative robots guided by these requirements and present a small user study in which we looked for the first response of residents suffering from moderate dementia and caregivers in a care institution.

2 New Friends Framework

The "New friends, old emotions" project is a Dutch-Spanish collaboration which targets the accessibility of robot-assisted therapy for caregivers that work with older adults suffering from dementia. Its first aim is to establish the need for guidelines for robot-assisted therapy by professional and informal caregivers.

Furthermore, the project targets an inventory of (1) experiences that some caregivers already have with robotic pets, (2) available pet robots and their suitability for this form of therapy, and (3) practices by caregivers that can be related to this form of therapy (e.g. using stuffed animals, real pets and activities that otherwise stimulate the senses of the subjects). Moreover, it aims to use the findings of these studies to provide guidelines and to offer supportive workshops for robot-assisted therapy.

The consortium that carries out this project consists of Dutch and Spanish institutions that have technical experience with (pet) robots, experience with field studies concerning older adults, or specific expertise in both studying and working with older adults suffering from dementia. Also a part of the consortium is eldercare institutions in different cities of the Netherlands. The project management is carried out by the Robotics research group of Windesheim Flevoland University of Applied Sciences in Almere, the Netherlands.

3 Developing a requirements list

To establish our goal, we decided to gather both qualitative and quantitative data from questionnaires completed by caregivers that worked in eldercare institutions in the towns of Almere, Lelystad and Zuidlaren in the Netherlands and in the city of Madrid in Spain. Both in the Netherlands and in Spain, some caregivers had no experience in working with a pet robot, while others had worked with Paro.

The 17 caregivers from the Netherlands were all professionals, aged 19 to 61. They had a lower or higher professional education and they were all female. The 20 caregivers from Spain were aged 21 to 58. They were also female professionals except for one, and their education varied from lower professional to university.

The respondents were asked to fill out the questionnaire individually. This questionnaire (Table 1) consisted of (a) questions on knowledge of and experience with robot-assisted therapy and (b) the need for guidelines and (c) questions on requirements for suitable robots. Four of the questions (in Table 1 these are questions 3 to 6) were actually statements to be replied to on a five point Likert scale, indicating the extent to which they agreed (absolutely agree – agree – neutral - not agree - absolutely not agree). The espondents were aware that the answers on this scale corresponded with an attributed score, varying from 5 (totally agree) to 1 (totally not agree).

Table 1. Questionnaire items

1. Have you ever heard, seen or read about the use of a pet robot for older adults suffering from dementia?

2. Have you ever used such a robot?

Yes:	2a. Did you use specific directives? Yes: which ones and how did you get them? No: Why not? Would you like to have directives?	2b. Did you involve family members? Yes: Did it go well? Did you use directives? No: Would you want to? Why would or wouldn't you?
No	2c. Would you like to work with it? 2d. What would hold you back or stimulate you?	

Please indicate how much you agree with the following statements:

3. I believe that activities with pet-like robots may increase the quality of life for people suffering from dementia.
4. I (would) like to work with such robots
5. I find it important that there are directives for interventions with such robots
6. These directives should also make it possible for family members to do these interventions

7. What possibillities and properties should suitable pet robot have?
a. What features and qualities are necessary?
b. What features and qualities are desirable?
c. How do you expect that older people respond to these properties?
d. Which expressions are important? (eg facial expression wagging tail etc)
e. Why?

8. What possibillities and properties should a suitable pet robot certainly not have?

After the questionnaires were filled out, the respondents elucidated their answers in a conversation with one of the researchers. These were recorded.

4 Questionnaire results

4.1 Familiarity and guidelines

Most caregivers were more or less familiar with robot-assisted therapy. Of course, those from Madrid had even applied it, but nine out of eleven from the Netherlands had seen a short television documentary on this subject. Four of them compared it to their own experiences with real pets. In one case this was a dog, but the other three who all worked at the same eldercare institution in the city of Lelystad, reported that they kept a cat on their floor that they made to look like a real street with houses in the seventies. They reported positive effects of cuddling sessions with the cat, but also expressed that a robotic cat would be more beneficial, since it would always be willing to be cuddled.

Four other caregivers reported the use of stuffed animals to be more or less familiar, but even more the practice of "snoezelen", which aims to evoke emotions by stimulating the senses. They expected robot-assisted therapy to be beneficial since it could also evoke emotions.

All caregivers except for one expressed a need for guidelines and stated that robot-assisted therapy would be far more widely applied if these would be commonly available. Some indicated that guidelines were especially needed for dealing with unexpected responses that could also occur with similar activities that evoke emotions. They indicated that occasionally robotic pets could evoke anger, panic or sadness. Moreover several caregivers from the Netherlands reported that some related activities would occasionally evoke resistance, reluctance or even animosity by family members who experienced it as humiliating or insulting to see their fathers or mothers playing with stuffed animals. This could also be expected if it were robotic pets. A set of guidelines should also include directives on how to deal with this. The one caregiver who indicated that no guidelines were needed stated that she expected that this form of therapy would hardly be applied and that developing guidelines would be a waste of time and effort.

As Table 2 shows, the scores on the four Likert scale statements were generally "agree" or "totally agree". For each statement there were only one or two "neutral" scores.

Table 2. Descriptive statistics of s cores on items 3 to 6

	Minimum	Maximum	Mean	Std. Deviation
Item 3	3	5	4,19	,525
Item 4	3	5	4,39	,599
Item 5	4	5	4,64	,487
Item 6	2	5	4,11	,887

Table 3 shows an analysis of the differences between caregivers with and without experience with Paro: none of the questions resulted in significant answers.

Table 3. Difference in experience for items 3 to 6

	Item 3	Item 4	Item 5	Item 6
Mann-Whitney U	154,000	116,000	141,000	143,000
Sig (2-tailed)	,784	,112	,449	,547

Table 4 shows the (Spearman) correlation on the scores for items 3 to 6 plus age of the caregivers. There is significance for the correlation between and between Items 3 and 4, 4 and 5 and 5 and 6. The first correlation is a predictable one: the more caregivers believe in using pet robots, the more they are willing to work with it. The second one is remarkable: the ones who are willing to work with it, generally think they could benefit from good directives. The third indicates that caregivers who think they could benefit from guidelines also think it is good to work with family members.

Moreover, there is a strong correlation between Age and Item 6. This could indicate that older caregivers are more willing to involve family members than younger ones.

Table 4. Correlation items 3 to 6 and Age

		Item 3	Item 4	Item 5	Item 6	Age
Item 3	Correlation	1,000	,392*	,255	,321	,188
	Sig. (2-tailed)	.	,017	,127	,053	,265
Item 4	Correlation	,392*	1,000	,328*	,233	-,003
	Sig. (2-tailed)	,017	.	,047	,165	,986
Item 5	Correlation	,255	,328*	1,000	,368*	-,151
	Sig. (2-tailed)	,127	,047	.	,025	,372
Item 6	Correlation	,321	,233	,368*	1,000	,447**
	Sig. (2-tailed)	,053	,165	,025	.	,006

4.2 Requirements

We had asked the caregivers to indicate which requirements were necessary and which ones were desirable. In order to quantify the results some preferred pet characteristics were combined by the researchers. For example, some caregivers indicated the skin should be soft, some said it should be furry and some indicated it should be 'pettable like a real animal skin'. All these were categorized under 'soft pettable fur' (listed as requirement 1).

Answers that were given to question 8 were processed in a similar way, since they consistently were the reversed versions of the positive expressions. For example, it was often indicated that the robot should not be noisy which is essentially the same as requirement 3 (mechanical parts are noiseless) and a remark 'It should really not be to breakable' could be categorized under 12 (can withstand rough handling). All these requirement counts that where derived from answers to question 8 where categorized as necessary.

In many cases pet features were mentioned repeatedly, both as necessary and desired features and sometimes even again in reversed descriptions answering question 8. In that case, the requirement was only counted once as a necessary feature.

One participant simply stated that the robotic pet should stimulate the user. We did not count this as a requirement, because this is already one of the principle goals of robot-assisted therapy.

Table 5 shows the results of this count, for the caregivers that had worked with Paro (Exp) and the ones with no such experience (Not), followed by the total counts.

Note that each cell contains the counts for necessary (before the slash) and desired (after the slash) requirements.

The 'soft pettable fur' was mentioned in different characterizations by most caregivers of the group with no experience and many of them mentioned appropriate sounds and noiseless mechanical parts. Some mentioned detachable fur (which is actually hardly found for robotic pets).

We may conclude that most caregivers were familiar with robot-assisted therapy. Moreover, they were generally quite willing to apply it if they did not already do. Remarkably they easily linked this form of therapy to familiar activities, like working with real pets, stuffed animals and sensory stimulation. Also, caregivers generally agreed on the need for guidelines.

Table 5. Requirements for caregivers with and without experience with Paro

Requirements	Exp	Not	Total
1. Soft pettable fur	2/-	11/1	13/1
2. Appropriate responses/sounds	4/1	8/7	12/8
3. Looks like a real life pet	5/1	4/1	9/2
4. Mechanical parts are noiseless	-/-	7/2	7/2
5. Young or innocent looking.	4/-	3/1	7/1
6. Nice/not scary	1/-	6/1	7/1
7. Huggable (right size cuddle with)	-/-	6/-	6/-
8. Realistic movements (fluent/natural)	1/-	4/2	5/2
9. Adaptable (shut functions on/off)	1/-	2/2	3/2
10. Autonomous system	-/1	3/-	3/1
11. Mobile (easy to take with you)	2/-	2/-	4/-
12. Can withstand rough handling, solid	1/-	2/-	3/-
13. Easy to use	2/-	3/-	5/-
14. Variety of behaviors and sounds	2/1	1/-	3/1
15. Fur is detachable (to be washed)	1/-	2/-	3/-
16. Cartoonish appearance	-/-	1/-	1/-
17. Flashy/draws attention	-/-	1/1	1/1

Looking at the generated list of requirements we see that a soft pettable fur is mentioned often especially by the caregivers without experience. Remarkable is that the noiselessness of the mechanical part is only mentioned by caregivers without experience.

This list contains 17 items that can be prioritized according to the necessity as indicated by the participants, but also by the frequency of the combined categories. We chose to list them in Table 5 only by the frequency of the necessity.

5 Exploring alternative robotic pets

To explore alternative pets, we selected a few alternative robotic pets and set up a small user study. Subsequently we interviewed the involved caregivers.

5.1 Strategy

We made an inventory of commercially available robotic pets and selected a seal puppy and a cat. Next to realistic looking pet robots, we wanted to use more cartoon-ish designed pets and selected a baby dinosaur and a bear.

The seal puppy is produced by WowWee, and is an example of the Alive Baby Animals series. Its current price is €35.- and it has the appearance of a Paro seal robot, but is much smaller and lighter. Moreover it is limited in functionality compared to Paro: it can only open and close its mouth and produce baby seal cries. Its mechanical parts are also much noisier.

Fig. 2. Used pet robot – clockwise: Seal puppy, Pleo, Bear and Cat (Cuddlin Kitty)

The cat is a 'FurReal Friends Lulu Cuddlin Kitty', produced by Hasbro. The cost is €60.-. She has a lying position and responds to caressing by shutting her eyes briefly and by making a purring sound. After being petted for a longer time, she lifts her leg and turns on her back so her chest and belly can be petted. When the user stops this, she turns back in her original position. She has multiple sensors in head, back, chest and belly and a microphone. She detects voice and responds to it by meowing. Its mechanical parts are as noisy as the Baby Seal.

The dinosaur is a Pleo robot. It is in fact a baby Camarasaurus, which has just hatched. This means it still has to develop skills and personality when it is received. Its development depends on how it is fed and treated (petting a lot makes it nicer). It features two microphones that are used for voice detection, a camera which is used to localize people and objects and multiple touch sensors on the head and back which make it responsive to petting. Its mechanical parts are much less noisy compared to the previous pets.

The bear is a robot that has been developed by the Robotics Research group of Windesheim Flevoland University of Applied Sciences. It is a regular stuffed bear equiped with a robotic frame made with Arduino, which can easily be transferred to other stuffed animals. This makes it possible to test different embodiments. Moreover, the functionalities (which are still limited at this time) can be turned on and off independently which will enable us in a later stage to establish the importance of each feature. The bear also has WIFI connectivity, so it can be remotely controlled in a wizard-of-oz setup.

We thus had four robots that could all be categorized according to the attributes 'familiar' and 'life like': the seal is not familiar as a pet, but life like; the cat is both life like and familiar; the bear is familiar but not life like and Pleo is neither. However, as Table 6 shows, we have to bear in mind that the available functionalities of the four pets have more differences than these. Nevertheless, they are all more or less comparable to Paro, although Paro fits most requirements and is far superior in weight (it is much heavier – according to some caregivers it is even too heavy) and interactivity to any of the alternative robots.

Table 6. Alternative robots fitting the requierements

Requirements	Seal	Bear	Cat	Pleo	Paro
1. Soft pettable fur	+	+	+	+/-	+
2. Appropriate responses/sounds	+	+/-	+	+	+
3. Mechanical parts are noiseless	+/-	+/-	-	+/-	+/-
4. Young or innocent looking.	+	+	+	+	+
5. Nice/not scary	+	+	+	+/-	+
6. Huggable (right size cuddle with)	+	+	+	+	+/-
7. Realistic movements (fluent/natural)	+	+/-	+/-	+/-	+
8. Looks like a real life pet	+/-	+/-	+	-	+/-
9. Adaptable (shut functions on/off)	-	+	-	-	+
10. Autonomous system	+	+	+	+	+
11. Mobile (easy to take with you)	+	+	+	+	+/-
12. Can withstand rough handling, solid	-	-	-	-	+
13. Easy to use	+	+	+	+	+
14. Variety of behaviors and sounds	-	-	-	+	+
15. Fur is detachable (to be washed)	-	-	-	-	-
16. Cartoonish appearance	-	+	-	+	-
17. Flashy/draws attention	+/-	+/-	+/-	+/-	+/-
+/-	**4**	**6**	**4**	**2**	**8**

5.2 Experimental procedure

We set up a session of one hour with fifteen patients who suffered moderate dementia. They were sitting in a circle as would be usual for group activities, when a caregiver presented the first robotic pet (the cat) to each participant for approximately one minute. The participant could take the robot on his or her lap, touch it and talk to it. When presenting it, the caregiver asked if the participant liked the robot and if he or she thought it was real. After it had been presented to all participants, the next robot was presented (subsequently the seal, the bear and the dinosaur). Researchers were able to observe the responses. They specifically noted smiles caresses, hugs, kisses and talking directed to the robotic pet, and also the response (if any) to the questions of the caregiver.

5.3 Interviews

We interviewed eleven caregivers (nurses and therapists) that were present at the department where we carried out the experiment. They were not only able to see the pet robots we used, but also to pick them up and explore the interaction. All of them had experience with robot-assisted therapy, using Paro.

They were asked to rate the suitability of each of the used pet robots for therapy activities by rating it on a scale from one (absolutely suitable) to five (absolutely not suitable). Subsequently they were asked to elucidate their rating.

5.4 User study results

Table 7 shows only a part of the responses we observed. First of all, we felt unable to record the smiles (as has been done in related studies [13]), since we could often not differentiate between a smile caused by the caregiver and a smile caused by the robot and some participants were simply smiling during the entire session.

Also responses to caregivers questions caused some difficulty, since many participants gave no verbal reply to it. For the cat, three participants said it was real and four participants said it was not real. The seal was claimed to be real by one person and not real by four. After the cat and the seal were presented, the caregiver stopped asking this question.

Table 7. Patient responses to the robotic pets

	Pleo	Cat	Seal	Bear
like	6	12	13	6
caress	6	10	11	4
talk	1	7	4	2
hug	0	0	3	6
kiss	4	0	4	0

When analyzing the responses, we noticed that there were clear differences between the participants. Where some responded to the cat and not to the seal, for others the response was the other way around. And some did response more to the bear than to other robotic pets.

Table 7 shows that the seal and the cat scored the highest amount of patients’response, especially on ‘likes’ and ‘caresses’. The cat scored the most ‘talks’ and the bear the highest amount of hugs. Pleo scored lower on most counts except for kisses, which is in line with the often mentioned requirement of ‘looking like a real life pet’ in Table 5. We also noted that four participants indicated to be scared of it. This was something that none of the participants indicated with any of the other pet robots except for one participant with the cat: she indicated that she had always been afraid of cats.

5.5 Caregiver interview results

To process the rating scores appropriately so that a higher score would indicate a higher appreciation, we reversed them.

As Table 8 shows, the highest score was for the baby seal robot. The caregivers indicated that they were charmed by its simplicity and softness. Two caregivers even indicated that they liked it more than Paro, because it was lighter, easier to use, more mobile and because they would be less afraid to break it or have it broken. The second highest score was for the cat. Caregivers liked it because it was a realistic representation of an animal that could be referred to as a pet (contrary to all the other pet robots). However, they disliked its movements that were 'too robotic'. The third highest score was for the bear, which was often considered appropriate, but too limited in functionalities and too big. The lowest score was for the Pleo. Many caregivers found it cute, but not familiar enough and 'too reptilious'.

Table 8. Patient responses to the robotic pets

	Total	Minimum	Maximum	Mean	Std. Deviation
cat	49	3	5	4,18	,751
seal	46	3	5	4,45	,688
pleo	39	2	4	3,00	,775
bear	33	3	5	3,82	,751

6 Conclusion, discussion and future research

A first conclusion from the first part of this research is that most caregivers are willing to work with, or at least explore robot-assisted therapy with people suffering from dementia.

A second conclusion could be that furry skin, appropriate response and a silent operating mechanism are the most important requirements according to caregivers. However, much more research can be done on these requirements, for example by focusing on their specification. We could take this list and ask caregivers to attribute a weight to them.

A third finding of this study is that many caregivers spontaneously linked robot-assisted therapy to activities like working with real pets, stuffed animals and evoking emotions by stimulating the senses (snoezelen). When developing guidelines we could indeed learn from caregivers' experiences with these activities and establish if they could be applied to the use robotic pets.

A fourth conclusion is that some older adults in a stage of moderate dementia differ in their response to different types of pet robots. Further research could specify this and establish if there is a predictable pattern (a typology of patients linked to a typology of pet robots) or even that a caregiver should have a collection of different pet robots rather than one specific one.

Finally we conclude that caregivers are open to alternatives to Paro for robot-assisted therapy in dementia and that some of them may even prefer an alternative. This invites us to further explore these alternatives and research the importance of different requirements.

Acknowledgment

We thank the management and caregivers working at De Overloop and De Archipel in Almere, De Enk in Zuidlaren and at De Hanzeborg in Lelystad as well as the staff of the Alzheimer Center Reina Sofia Foundation, Madrid. We are very grateful for their time.

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A Kind of Snoezelen – Requirements for a Therapeutic Robot for Older Adults With Dementia According to Caregivers*

M. Heerink, J. Albo-Canals, M. Valenti-Soler and P. Martinez-Martin

Abstract— **Robot-assisted therapy has been researched for more than a decade and has been dominated by the seal shaped robot Paro. It is however unclear unto what extent the development of Paro has been based upon requirements that are mentioned by care professionals. In this pilot study we interviewed two groups of healthcare professionals: one that has been using Paro and one that has not been using Paro. We asked both for the requirements that would suit the target group of dementing inhabitants best and what the relation between these requirements and the stage of dementia was. Results show small differences between these groups, a clear link to other activities and also a demand for more variation in usable pet robots. Moreover, all professionals expressed the need for guidelines for robot-assisted therapy and the exchange of experiences.**

I. Introduction

Much research has been done on the use of robotic pets for older adults suffering from dementia, suggesting this is a successful form of therapy [1-4]. Although most research has been done in Japan (especially by Wada and Shibata) and with the same seal shaped robot called Paro, it is generally assumed it improves mental and physical wellbeing and results in a more active interaction of the subjects with their environment [5].

Although there are some alternatives [6-10], Paro is by far the most widely used robotic pet for this purpose. This could be due to the fact that Paro is the only robotic pet that is both especially developed for this purpose and commercially available. However, acquiring a Paro is quite an investment since it costs close to five thousand dollars [11]. Eldercare professionals that would like to try working with a robotic pet but have a very limited budget may look for alternatives. These would be pet robots that would meet the requirements that would make them suitable for robot-assisted therapy.

In this explorative study we want to elicit and specify these requirements by focusing on professional caregivers working with older adults who suffer from dementia. These caregivers may have experience with similar types of interventions, like using real pet animals, stuffed animals or other techniques that stimulate the senses for which the term'snoezelen' is used. Snoezelen is also called or Multi-Sensory Stimulation (MSS), and is a widely used and accepted approach to nursing home residents suffering dementia [12]. It was developed in the Netherlands (it is Dutch verb) but is becoming more popular in other industrialized countries. [13]. Snoezelen can be defined as an approach that actively stimulates the senses using light, sound, smell, touch and taste [14].

Figure 1. Paro

The caregivers that are subject to our study may or may not be familiar with robot-assisted therapy. If they are not, this could be due to the unfamiliarity of the possibilities of this form of therapy, but also by the inaccessibility: for caregivers who are interested in applying this therapy, there are hardly any practical guidelines available on how to use which type of robot in which state of dementia, how to deal involve family members and how to respond to any negative responses. It could in that case very well be that a

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comprehensible set of guidelines would lead to a wider application of robot-assisted therapy.

We also have to take into account that he caregivers who are familiar with robot-assisted therapy - and especially the ones who have been applying it - may give different responses when asked for the requirements for a suitable robot.

This paper presents the results of an explorative study at the very start of this project. The goal was to elicit and specify requirements according to professional caregivers for a pet robot that can be used in therapeutic interventions with older adults suffering from dementia. Moreover, we wanted to establish how the familiarity of this form of therapy and the experience of applying it would influence the elicitation and specification of these requirements.

In order to achieve this, we wanted to map (a) the familiarity of robot-assisted therapy, (b) the need for guidelines by professional caregivers in Spain and the Netherlands, and (c) produce an inventory of requirements for a suitable robot according to these caregivers.

In the following section we will present the project of which this study is a part. Next, in section III, we will discuss the used questionnaire and respondents. In section IV we will present the results of (a) questions on experience and guidelines and (b) the requirements inventory. In section V we will draw conclusions from this and subsequently we will present a brief discussion.

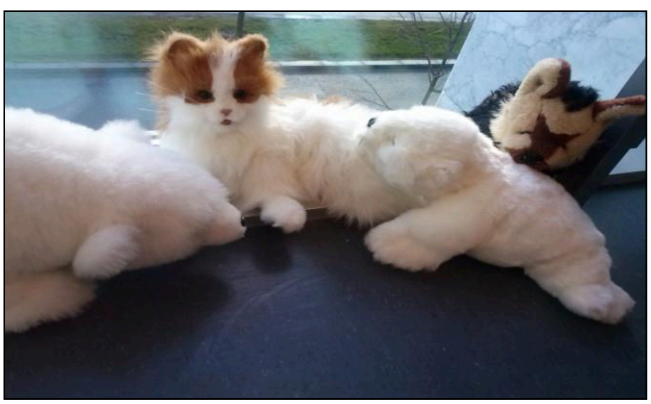

Figure 2. Alternative robotic pets

II. New Friends Framework

The "New friends, old emotions" project is a Dutch-Spanish collaboration which targets the accessibility of robot-assisted therapy for caregivers that work with older adults suffering from dementia. Dutch government funding mainly finances it. Its first aim is to establish the need for guidelines for robot-assisted therapy by caregivers.

Furthermore, it targets an inventory of (1) experiences that some caregivers already have with robotic pets, (2) available pet robots and their suitability for this form of therapy, and (3) practices by caregivers that can be related to this form of therapy (e.g. using stuffed animals, real pets and activities that otherwise stimulate the senses of the subjects). Moreover, it aims to use the findings of these studies to provide guidelines and to offer supportive workshops for robot-assisted therapy.

The consortium that carries out this project, consists of Dutch and Spanish universities that have technical experience with (pet) robots, experience with field studies concerning older adults, or specific expertise in both studying and working with older adults suffering from dementia. Also a part of the consortium is eldercare institutions in different cities of the Netherlands. The project management is carried out by the Robotics research group of Windesheim Flevoland University of Applied Sciences in Almere, the Netherlands.

TABLE I. Questionnaire items

1. Have you ever heard, seen or read about the use of a pet robot for older adults suffering from dementia?	
2. Have you ever used such a robot?	
Yes:	2a. Did you use specific directives? Yes: which ones and how did you get them? No: Why not? Would you like to have directives? 2b. Did you involve family members? Yes: Did it go well? Did you use directives? No: Would you want to? Why would or wouldn't you?
No	2c. Would you like to work with it? 2d. What would hold you back or stimulate you?
Please indicate how much you agree with the following statements:	
3. I believe that activities with pet-like robots may increase the quality of life for people suffering from dementia.	
4. I (would) like to work with such robots	
5. I find it important that there are directives for interventions with such robots	
6. These directives should also make it possible for family members to do these interventions	
7. What possibillities and properties should suitable pet robot have? a. What features and qualities are necessary? b. What features and qualities are desirable? c. How do you expect that older people respond to these properties? d. Which expressions are important? (eg facial expression wagging tail etc) e. Why?	
8. What possibillities and properties should a suitable pet robot certainly not have?	

III. Questionnaire and Participants

To establish our goal, we decided to gather both qualitative and quantitative data from questionnaires with caregivers that worked in eldercare institutions in the cities of

Almere and Lelystad in the Netherlands and in the city of Madrid in Spain. The caregivers in the Netherlands had no experience in working with a pet robot, while all of the professionals in Madrid had worked with Paro.

The 11 caregivers from the Netherlands were all professionals, aged 19 to 58. They had a lower or higher professional education and they were all female. The 8 caregivers from Spain were aged 25 to 58. They were also female professionals except for one male professional, and they reported to have an education that varied from lower professional to university.

The respondents were asked to fill out the questionnaire individually. This questionnaire (see Table 1) consisted of (a) questions on knowledge of and experience with robot-assisted therapy and (b) the need for guidelines and (c) questions on requirements for suitable robots. Four of the questions (in the listing in Table 1 these are questions 3 to 6) were actually statements to be replied to on a five point Likert scale, indicating the extent to which they agreed (absolutely agree – agree – neutral – not agree - absolutely not agree). The respondents were aware that the answers on this scale corresponded with an attributed score, varying from5 (totally agree) to 1 (totally not agree).

After the questionnaires were filled out, the respondents had a chance to elucidate their answers in a conversation with one of the researchers. These were recorded.

IV. RESULTS

A. *Experience and guidelines*

Most caregivers were more or less familiar with robot-assisted therapy. Of course, those from Madrid had even applied it, but nine out of eleven from the Netherlands had seen a short television documentary on this subject. Four of them compared it to their own experiences with real pets. In one case this was a dog, but the other three who all worked at the same eldercare institution in the city of Lelystad, reported that they held a real cat on their floor. This floor was made to look like a real street with houses and even a bus stop in the seventies. They reported positive effects of cuddling sessions with the cat, but also expressed that a robotic cat would be more beneficial, since it would always be willing to be cuddled.

Four other caregivers reported the use of stuffed animals to be more or less familiar, but even more the practice of "snoezelen", which aims to evoke emotions by stimulating the senses. The expected robot-assisted therapy to be beneficial since it could also evoke emotions.

All caregivers expressed the need for guidelines and stated that robot-assisted therapy would be far more widely applied if these would be commonly available. Some indicated that guidelines were especially needed for dealing with unexpected responses that could also occur with similar activities that evoke emotions. They indicated that occasionally it could evoke anger, panic or sadness. Moreover some caregivers from the Netherlands reported that with familiar activities there could sometimes be resistance, reluctance or even animosity by family members who experienced it as humiliating or insulting to see their fathers or mothers playing with stuffed animals and this could also be expected if it were robotic pets. How to deal with this, should also be part of a set of guidelines.

As Table II shows, the scores on the four Likert scale statements were generally "agree" or "totally agree". For each statement there were only one or two "neutral" scores.

TABLE II. SCORES ON ITEMS 3 TO 6

	Minimum	Maximum	Mean	Std. Deviation
Item 3	3	5	4,21	,535
Item 4	3	5	4,53	,612
Item 5	4	5	4,68	,478
Item 6	3	5	4,32	,671

Table III shows an analysis of the differences between caregivers with and without experience with Paro. For item 4 there is a significant difference: the caregivers without experience score higher on the intention to work with a robot than the ones with experience.

TABLE III. DIFFERENCE IN EXPERIENCE FOR ITEMS 3 TO 6

	Item 3	Item 4	Item 5	Item 6
Mann-Whitney U	30,000	18,000	39,500	26,000
Sig	,156	,014	,645	,101

Table IV shows the (Spearman) correlation on the scores for items 3 to 6 plus age of the caregivers. There is significance for the correlation between Age and Item 6 and between Items 3 and 4. The first correlation could indicate that older caregivers are more willing to involve family members than younger ones. The second correlation is a predictable one: the more caregivers believe in using pet robots, the more they are willing to work with it.

TABLE IV. CORRELATION ITEMS 3 TO 6 AND AGE

		Item 3	Item 4	Item 5	Item 6	Age
Item 3	Correlation	1,000	,532*	,254	,093	-,118
	Sig. (2-tailed)	.	,019	,294	,706	,632
Item 4	Correlation	,532*	1,000	,380	,277	,186
	Sig. (2-tailed)	,019	.	,109	,251	,447
Item 5	Correlation	,254	,380	1,000	,411	-,010
	Sig. (2-tailed)	,294	,109	.	,081	,966
Item 6	Correlation	,093	,277	,411	1,000	,461*
	Sig. (2-tailed)	,706	,251	,081	.	,047

B. Requirements

We had asked the caregivers to indicate which requirements were necessary and which ones were desirable. We tried to combine familiar descriptions so we could easily quantify the results. For example, some caregivers indicated the skin should be soft, some said it should be furry and some indicated it should be 'pettable like a real animal skin'. All these were categorized under 'soft pettable fur' (listed as requirement 1).

TABLE V. REQUIREMENTS FOR CAREGIVERS WITH AND WITHOUT EXPERIENCE WITH PARO

Mentioned requirements	Exp	Not	Total
1. Soft pettable fur	1/-	10/-	11/-
2. Appropriate responses/sounds	2/-	7/5	9/5
3. Mechanical parts are noiseless	-/-	7/2	7/2
4. Young or innocent looking.	4/-	2/1	6/1
5. Huggable (right size cuddle with)	-/-	6/-	6/-
6. Realistic movements (fluent/natural)	1/-	4/2	5/2
7. Looks like a real life pet	5/1	-/-	5/1
8. Able to shut functions on/off independently	1/-	2/1	3/1
9. Autonomous system	-/1	3/-	3/1
10. Mobile (easy to take with you)	2/-	1/-	3/-
11. Can withstand rough handling, solid	1/-	2/-	3/-
12. Easy to use	2/-	-/-	2/-
13. Variety of behaviors and sounds	2/1	-/-	2/1
14. Fur is detachable (to be washed)	-/-	2/-	2/-
15. Responsive to the user	1/1	-/-	1/1
16. Makes realistic sounds	1/-	-/-	1/-
17. Cartoonish appearance	-/-	1/-	1/-

Numbers indicate the counts for necessary/desirable items

Also answers that were given to question 8 could be processed, since they consistently were the reversed versions of the positive expressions. For example, it was often indicated that the robot should not be noisy which is essentially the same as requirement 3 (mechanical parts are noiseless) and a remark 'It should really not be to breakable' could be categorized under 11 (can withstand rough handling). All these requirement counts that where derived from answers to question 8 where categorized as necessary.

In many cases features were mentioned repeatedly, both as necessary and desired features and sometimes even again in reversed descriptions answering question 8. In that case, the requirement was only counted once as a necessary feature.

One participant simply stated that the robotic pet should stimulate the user. We could not count this remark as a requirement.

Table V shows the results of this count, for the caregivers that had worked with Paro (Exp) and the ones with no such experience (Not), followed by the total counts. Note that each cell contains the counts for necessary (before the slash) and desired (after the slash) requirements.

The 'soft pettable fur' was mentioned in different characterizations by almost each caregiver of the group with no experience and the noiseless mechanical parts by most of them. Some of them mentioned detachable fur (which is actually hardly found for robotic pets). The caregivers with experience mentioned comparatively much that it should look young and innocent and resemble a real life pet.

However, in general the appearance related features were mentioned far more often by the caregivers without experience, even if the larger group size (11 versus 8) is taken into account. As Table VI shows, for other categories the difference in counts is fairly consistent with the difference in-group size.

TABLE VI. CATEGORIZED REQUIREMENTS

Category of mentioned requirements	Exp	Not	Total
The way it appears (1,3-5,7,17)	10/1	26/3	36/4
The way it is used (8-12,14)	6/1	10/1	16/2
The way it behaves (2,6,13,15,16)	7/2	11/7	18/9

V. CONCLUSIONS

We may conclude that most of the caregivers were familiar with robot-assisted therapy. Moreover, they were generally quite willing to apply it if they did not already do.

Remarkably they easily linked this form of therapy to familiar activities, like working with real pets, stuffed animals and evoking emotions by stimulating the senses.

Also, caregivers generally agreed on the need for guidelines.

Looking at the generated list of requirements we see that a soft pettable fur is mentioned often especially by the caregivers without experience. Remarkable is that the noiselessness of the mechanical part is only mentioned by caregivers without experience.

This list contains 17 items that can be prioritized according to the necessity as indicated by the participants, but also by the frequency.

VI. Discussion and further research

We have interviewed caregivers from four different eldercare institutions, three of the in or near Almere. This makes it impossible to state that most caregivers in the Netherlands are familiar with robot-assisted therapy. Nevertheless it is remarkable that at the visited institutions, this form of therapy was known and that caregivers were willing to work with it. However, in further research it would be advisable to obtain a larger and more differentiated group of participants.

Moreover, we have to take into account that all the caregivers from Madrid were experienced and the ones in the Netherlands were not. We are not aware of cultural differences that could be of influence in this context, but research would certainly benefit from a mix of experienced and inexperienced caregivers from both countries.

Further research could focus on the specification of found requirements. We could take this list and ask caregivers to attribute a weight to them. Subsequently we could use this list to compare different robotic pets and establish their suitability for robot-assisted therapy. Moreover we could use it to develop a more affordable robotic pet if it does not appear to be available.

Also the finding that caregivers without experience with robot therapy have a higher intention to work with a robot than the ones who have experience with it needs further research. It could be related to the curiosity of the caregivers without experience, but also there could be a certain disappointment with the experienced ones. In the latter case we would need to find out what experience leads to this disappointment.

One of the most prominent findings of this study could be the fact that many caregivers from the Netherlands spontaneously linked robot-assisted therapy to activities like working with real pets, stuffed animals and evoking emotions by stimulating the senses (snoezelen). When developing guidelines we could indeed observe the experience they have with these activities and establish if they could be applied to the use robotic pets.

Acknowledgment

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